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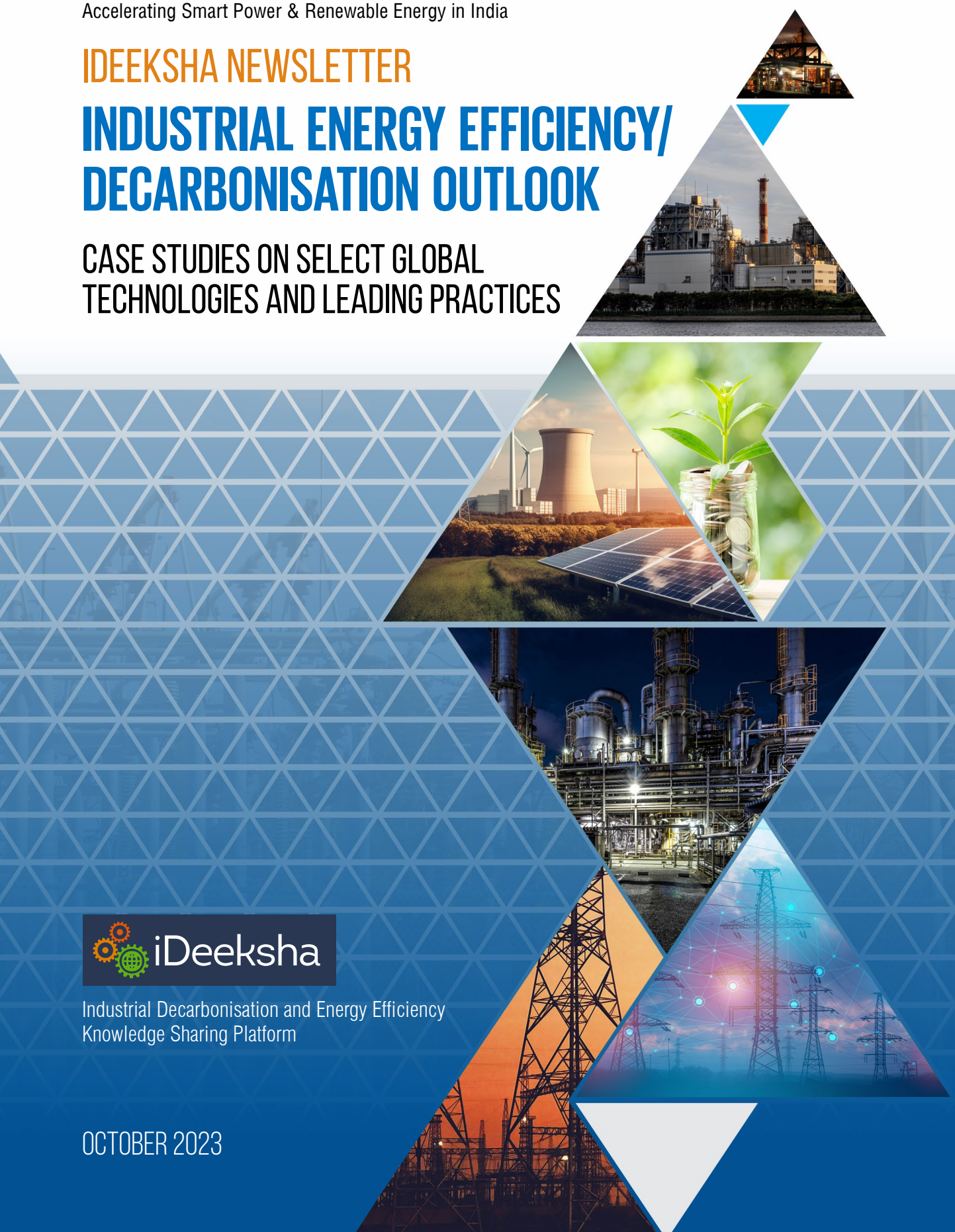
IDEEKSHA NEWSLETTER

INDUSTRIAL ENERGY EFFICIENCY/ DECARBONISATION OUTLOOK

CASE STUDIES ON SELECT GLOBAL TECHNOLOGIES AND LEADING PRACTICES



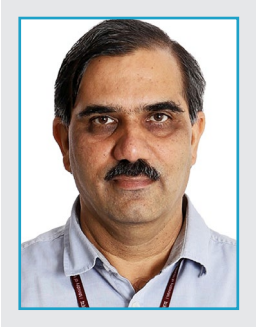
iDeeksha

Industrial Decarbonisation and Energy Efficiency Knowledge Sharing Platform

OCTOBER 2023

Contents

Message From
MR. ABHAY BAKRE
Director General, Bureau of Energy Efficiency



Warm greetings to Industry friends and Colleagues!

India's remarkable growth trajectory and unwavering commitment to a sustainable future is evident as we embark on an ambitious path. Under the guidance of the Ministry of Power, the Bureau of Energy Efficiency (BEE) has been persistent in strengthening India's energy security and promoting energy efficiency through concerted efforts.

Our ambitious commitments made during the COP26 summit in Glasgow, emphasises on India's determination towards reducing total projected carbon emissions by one billion tons, reducing carbon intensity of GDP by less than 45% by 2030, and achieving net-zero carbon emissions by 2070. Central to fulfilling these COP26 commitments and ensuring energy security is the crucial aspect of Energy Efficiency (EE) and decarbonisation of the industrial sector. According to a recent study by IEA, there was a ~1% rise in global energy consumption. Concurrently, energy-related carbon emissions demonstrated a growth of 0.9%, reaching ~36.8 Gt in 2022. The global energy efficiency progress has increased to over 2% in 2022 from 0.5% in 2021. This progression is instrumental, as without it, the energy demand would have been three times its current magnitude.

The Bureau of Energy Efficiency (BEE) has been vanguard in promoting EE in various demand sectors, with a special focus on the industrial sector, as it is one of the major contributors to total GHG emissions in India and holds immense energy-saving potential. Our Perform, Achieve, and Trade (PAT) scheme, now in its eighth cycle, has been instrumental in orchestrating the adoption of various low-hanging energy efficiency measures by large energy-intensive industries in thirteen sectors, with more sectors to be included soon. As we continue striving to achieve the targets set under the PAT scheme, the adoption of emerging low-carbon technologies becomes imperative for unlocking the next level of incremental savings and decarbonisation.

To support industries in their journey towards decarbonisation, I am pleased to introduce the IDEEKSHA platform which was launched by Mr. R.K. Singh, Hon'ble Cabinet Minister for Power and New and Renewable Energy, at 21st Foundation Day of BEE and a Decade of PAT Scheme event on March 01, 2023. The platform has been developed by the Accelerating Smart Power and Renewable Energy in India (ASPIRE) programme in collaboration with the Bureau of Energy Efficiency (BEE). ASPIRE is a bilateral programme being implemented by the UK Government Foreign Commonwealth and Development Office (FCDO), in association with the Ministry of Power (MoP) and Ministry of New and Renewable Energy (MNRE), Government of India.

IDEEKSHA Platform serves as a one-stop shop solution, catering to all the needs of Indian energy-intensive industries. It offers access to databases of proven and emerging technologies and their global providers, fostering peer-to-peer learning, sharing best practices across sectors, providing energy management tools, cutting-edge technologies, data sources, and knowledge repositories, thereby fostering knowledge and commercial partnerships.

It brings me pleasure that IDEEKSHA Platform is publishing its fourth newsletter, featuring national and international case studies on energy efficient, low carbon technologies and best practices. I am confident that this carefully curated newsletter will empower our energy intensive industries with transformative insights, catalysing deeper explorations into sustainable pathways.

I congratulate the authors of this newsletter and hope that the information presented will be useful for the stakeholders.

Message From
ALEX ELLIS

British High Commissioner to the Republic of India

Climate change is an existential challenge for our race and planet. Increasing numbers of extreme weather events around the world show the risks to our livelihoods, jobs and the natural environment.

So we need to act together if we are avert the worst impacts of climate change. At COP26 in Glasgow, we did just that. Almost 200 countries came together to sign the Glasgow Climate Pact which strengthens our resilience to climate change, to cut greenhouse gas emissions and to provide finance for the green transition. Prime Minister Modi proposed ambitious new targets for 2030 and pledged India would have net zero emissions by 2070. A year later, at COP 27, the Government of India published a Long-Term Strategy, setting out how India will achieve these targets.

To go further down the path of decarbonisation requires renewed focus on the industrial sector. Industries are one of the most significant contributors to emissions in India - around 25% of total emissions, second only to power generation. India's Long-Term Strategy sets out how it might develop an efficient and innovative low-emission industrial system. It highlights the opportunities to improve energy and resource efficiency, material efficiency and recycling, to strengthen the circular economy and to promote emerging technologies such as green hydrogen and carbon capture and storage technologies.

The UK must act as well, so it recently established the Energy Efficiency Taskforce to reduce energy demand through promoting energy efficiency across the economy. The taskforce will work to reduce total UK energy demand by 15% from 2021 levels by 2030, across domestic and commercial buildings and industrial processes.

The UK and India are also working together on the green transition and industrial energy efficiency. In October 2021, we launched a new UK-India bilateral programme: "Accelerating Smart Power and Renewable Energy" (ASPIRE) which aims to work with India to reach India's 2030 targets.

I am delighted to announce that under ASPIRE, 'IDEEKSHA: Industrial Decarbonisation and Energy Efficiency Knowledge Sharing Platform' has been developed in collaboration with the Bureau of Energy Efficiency (BEE). The IDEEKSHA platform will share best practices and Industrial Energy Efficiency and Decarbonisation (IEED) technologies among energy intensive industries. The newsletters will provide case studies on new and emerging low-carbon technologies and industry best practices. I hope that the information in these will help industries in reducing their energy and carbon consumption, contributing to India's efforts to achieve its climate goals.

Introduction

About ASPIRE Programme

Accelerating Smart Power and Renewable Energy (ASPIRE) is a bilateral programme being implemented by the UK Government's Foreign Commonwealth and Development Office (FCDO), in association with the Ministry of Power and Ministry of New and Renewable Energy (MNRE), Government of India (GoI). KPMG is the implementation advisor to FCDO in relation to the ASPIRE programme. Idam Infrastructure Advisory Private Limited (India) and Carbon Trust (UK) are the key consortium members.

Industrial Energy Efficiency and Decarbonisation is a key thematic area of support under the ASPIRE programme which is being implemented in association with Bureau of Energy Efficiency (BEE), GoI.

The objectives of the ASPIRE programme are to:

1. Catalyse increased investment across the power sector and renewable energy in India which supports energy security and economic growth that is inclusive, low carbon, leads to poverty reduction, and supports action on climate change.

2. Catalyse increased trade and investment opportunities and mutually beneficial economic relationships between Indian and international entities.

About IDEEKSHA Platform

Under the ASPIRE programme, a Knowledge Exchange Platform (KEP) – '**IDEEKSHA: Industrial Decarbonisation and Energy Efficiency Knowledge Sharing Platform**' has been developed in collaboration with the Bureau of Energy Efficiency (BEE) to promote and share best practices and energy-efficient technologies among large-scale industries. The IDEEKSHA platform was launched by Mr. R.K. Singh, Hon'ble Cabinet Minister for Power and New and Renewable Energy, Government of India during the 21st Foundation Day Event of BEE on March 01, 2023, in Delhi.

The IDEEKSHA platform is a one-stop shop for all energy efficiency/ decarbonisation needs of large industries covered under BEE's PAT Scheme. The IDEEKSHA platform would thus facilitate:

- Exchange of knowledge and information to enhance peer to peer learning.
- Designated Consumers (DCs) in adoption of new and emerging IEED tools & technologies by facilitating access to Indian and global (including from the UK) technology suppliers.
- Access to a database of financial institutions.
- Access to IEED tools, technologies & technology providers available in India and globally.
- Access to data sources and knowledge repositories to support knowledge translation.
- Sector/ industry specific workshops/ seminars to enhance EE measures.
- Knowledge and commercial partnerships.

This is the fourth of a series of newsletters that are being developed under the above initiative of ASPIRE programme for the 'IDEEKSHA Platform" and the Bureau of Energy Efficiency.

SECTION 1

INTERNATIONAL CASE STUDIES: IEED TECHNOLOGIES

International Case Studies: IEED Technologies

1.1 Unlocking Energy Efficiency Through Industrial Intelligence: Smartia

Introduction

Manufacturing, an energy-intensive industry is under substantial pressure to reduce costs and minimise environmental impact. However, most of the manufacturing plants lack the data and tools needed for intelligent energy management. The industry encounters several challenges which hinders their capacity to proactively enhance and optimise energy consumption including - (i) lack of granular visibility into energy usage, (ii) inability to pinpoint wasteful practises, (iii) data fragmentation across various systems, (iv) complex pricing structures, and (v) limited in-house expertise to actively manage energy consumption, etc.

Smartia, a UK-based AI and IoT technology company addresses these challenges through an industrial intelligence software platform combining artificial intelligence, IoT connectivity, and data analytics to empower manufacturers with transparency into their operational processes. Smartia's approach entails the aggregation and centralisation of data from across industrial assets and systems. Subsequently, machine learning techniques are applied to extract invaluable insights from this data, which are then presented through intuitive visualisations to end-users. This transformative process grants manufacturers detailed visibility into their energy consumption patterns, facilitating the identification of optimisation opportunities and laying the foundation for ongoing efficiency enhancements. With the swift deployment of non-intrusive sensors and a cloud-based infrastructure, Smartia delivers a potent combination of analytics and energy expertise that promotes sustainability and generates substantial cost savings.

Behind-the-Meter Energy Management

One exemplary application of Smartia's cutting-edge technology is **Smartia Energy Analytics**, which enables manufacturers to monitor and analyse energy usage with level of granularity, extending down to individual machines, production lines, and manufacturing cells. By providing this level of insight, it becomes possible to precisely discern how and where energy is being consumed within a manufacturing facility, thereby enabling the identification of specific avenues for savings. The provision of a comprehensive breakdown of energy consumption equips companies with a multidimensional understanding of their energy usage patterns. Businesses can leverage these insights to strategically pinpoint areas for improvement, significantly reducing waste and associated costs in the process.

Key features of Smartia's energy management solutions

Rapid Deployment and Non-Intrusive Sensors

Smartia's energy management solutions offers a swift implementation process, with deployment achievable in a couple of weeks. The use of non-intrusive sensors eliminates the need for costly integration efforts and minimises downtime. Smartia's cloud-based technology is designed to be vendor-agnostic, to enable seamless scalability on a global scale. The incorporation of user-friendly, non-intrusive sensors facilitates device connectivity without any operational disruptions. For instance, current transducers affixed to cables can measure electricity consumption without necessitating cable disconnection, providing valuable insights within few weeks of deployment.

Figure 1: Illustrative Dashboard for Smartia Energy Management Platform

Powerful Analytics

Smartia's industrial intelligence platform offers a robust analytics engine that transforms raw sensor and meter data into actionable insights. Leveraging machine learning algorithms, the system can analyse usage patterns to precisely identify areas of waste and opportunities for savings. Furthermore, the platform correlates energy consumption data with production statistics, weather conditions, and equipment information, to present optimisation opportunities.

Intuitive Dashboards Tailored to All Users

Smartia Energy Analytics offers a user-centric approach, delivering energy information tailored to the specific needs of various stakeholders within an organisation, including:

- Operators: to access live consumption data for the machines under their supervision.
- Plant managers: to gain the ability to scrutinise energy usage within production lines.
- Executives: to access facility-wide metrics, including the parameters linked to carbon emissions and cost objectives.
- Maintenance teams: to correlate energy data with equipment telemetry, facilitating early detection of faults.

Additionally, the platform includes built-in analytics capabilities that generate comprehensive reports, alerts, and recommendations, highlighting potential areas for energy savings and efficiency enhancements. The intuitive dashboards enable energy management accessible and actionable across all levels of the organisation, ensuring a holistic and data-driven approach to energy optimisation.

The key benefits of Smartia Energy Analytics include the following:

- **Visibility into Energy Consumption:** provides comprehensive visibility into energy consumption, allowing precise tracking of usage by process, product, facility area, or asset.
- **Energy Cost Calculations:** enables accurate calculations of energy costs on a per-product or batch basis, enhancing cost accountability.
- **Identification of savings opportunities:** through meter-level monitoring and analytics pinpointing excess energy use, highlighting cost reduction areas.
- **Utility bill reductions:** Efficiency gains, load optimisation, and optimal tariff selection are few strategies employed by Smartia to reduce utility bills, enabling substantial cost savings.
- **Load Ranking:** The platform ranks energy loads, enabling operators and managers to focus their efforts on significant opportunities for efficiency improvement.
- **Energy Management Practices:** Smartia enables organisations to refine their resource planning, establish precise performance targets, and continuously enhance operational efficiency by leveraging data-driven insights.
- **Progress towards carbon and sustainability goals:** by establishing energy consumption baselines and tracking carbon reductions.

Furthermore, the implementation of Smartia technology yields benefits beyond energy management, positively impacting various facets of manufacturing operations including, improving production efficiency, machine uptime, maintenance scheduling and quality control. Smartia has demonstrated impressive results in the manufacturing sector, achieving savings of up to **30%** on machines in continuous use and **~80%** savings on machines with sporadic usage through previous deployments[1] .

Potential Opportunity for Indian Manufacturing Industry

Smartia's cutting-edge industrial energy management solution holds immense potential for revolutionising the Indian manufacturing sector by enhancing energy efficiency and sustainability. By offering granular insights into energy consumption at the equipment level, identifying inefficiencies arising from idle assets, visualising peak demand periods, analysing production-consumption differentials, and enabling data-driven optimisation, Smartia empowers Indian industries to substantially reduce energy-related expenses. Moreover, its cloud-based deployment model ensures accessibility and affordability, eliminating the need for substantial upfront investments. This transformative solution has the potential to support the competitiveness of India's vital industrial sectors on the global stage, positioning them as leaders in intelligence-driven energy management.

1 For more details, please visit: https://www.smartia.tech/

1.2 Improving energy efficiency in fertiliser production through wastewater treatment resource recovery: CCm Technologies

Introduction

CCm Technologies specialises in an innovative technology designed to capture CO_2 emissions, particularly from industrial sources, and utilise it for the stabilisation of volatile chemicals, notably ammonia, found within waste materials. The resulting stable organic resources can serve as high-quality fertiliser products for agricultural purposes. CCm's process has the capability to harness CO_2 from gas-to-grid technology, recover ammonia to provide additional Nitrogen for crop cultivation, and efficiently utilise waste heat to reduce energy consumption during the drying process. This integrated approach offered by CCm's technology has the potential to streamline the recovery of CO_2, ammonia, and waste heat, culminating in the sustainable production of fertilisers.

Project demonstration

In a collaborative effort with Severn Trent Water (STW), CCm Technologies has implemented a low-carbon fertiliser production facility at the ST Minworth Waste Water Treatment site (WWT). This facility combines fertiliser production with sludge management and focuses on recovering essential plant nutrients from waste streams to create a high-value fertiliser product while simultaneously reducing energy consumption. Situated at Minworth, one of the United Kingdom's largest sewage treatment facilities and Severn Trent's flagship site, serving a population equivalent to **1.75 million** residents in Birmingham, this demonstration project features the installation of a **10,000-ton-per-annum** CO_2 utilisation unit for fertiliser production. The project aims to produce pelletised organic fertiliser by enhancing currently available, variable sludge feedstocks, representing a pioneering endeavour and the first of its kind in the water and wastewater treatment sector.

About the Innovation

The core innovation and primary advantage of this project lie in its ability to source nearly all of its physical inputs, including CO_2, ammonia, and organic base materials, from waste resources rather than relying on primary production. The CCm's process offers an efficient means of capturing and preserving recovered nutrients, ensuring their continued effectiveness as plant nutrients. The bulk nutrient density of the fertiliser produced is **500** times greater than the existing output. Moreover, modelling indicates the potential for significant carbon reductions, with the ability to offset ~**10,000** metric tons of CO_2 equivalents per year, as compared to carbon-intensive mineral fertiliser.

This advanced fertiliser product is suitable for scalable deployment, with the potential to curtail the release of Ammonia and Phosphate emissions into water bodies.

Figure 2: CCm's CO_2 utilisation in the fertiliser production plant at Minworth

The demonstration

CCm Technologies and STW successfully completed the installation of a sustainable fertiliser production plant with a yearly capacity of **10,000 tons**, utilising digestate sludge from Minworth. This versatile fertiliser facility was designed and constructed to seamlessly integrate reclaimed resources from the water industry including CO_2, ammonia, and waste heat.

Energy efficiency modelling focused on two key comparisons:

- The impact of ammonia recovery technology to reduce on-site energy consumption vs conventional nitrification, liquor treatment and additional ammonia recovery technologies.
- The impact of resource recovery integration for the production of sustainable fertiliser formulations vs conventional mineral fertiliser production routes.

CCm's sustainable fertiliser production process

The fertilizer production process utilizes four waste streams: concentrated ammonium from sewage water, carbon dioxide from anaerobic digester biogas combustion, waste process heat, and organic fiber from treated sewage sludge. Ammonium, found in urine and produced by protein decay in waste streams, poses environmental harm due to its reactivity. However, it can be stabilized into ammonium bicarbonate by mixing it with captured carbon dioxide generated from biogas combustion. Additional nutrients and calcium salts, derived from industrial by-products, are added to create a sludge of chalk and ammonium nitrate. This sludge is blended with fibers from wastewater digestate, acting as a solidifying binder. The material undergoes a drying process powered by waste process heat before being pelletized and bagged for distribution to farms. (Figure 3 demonstrates CCm's sustainable fertiliser production process)

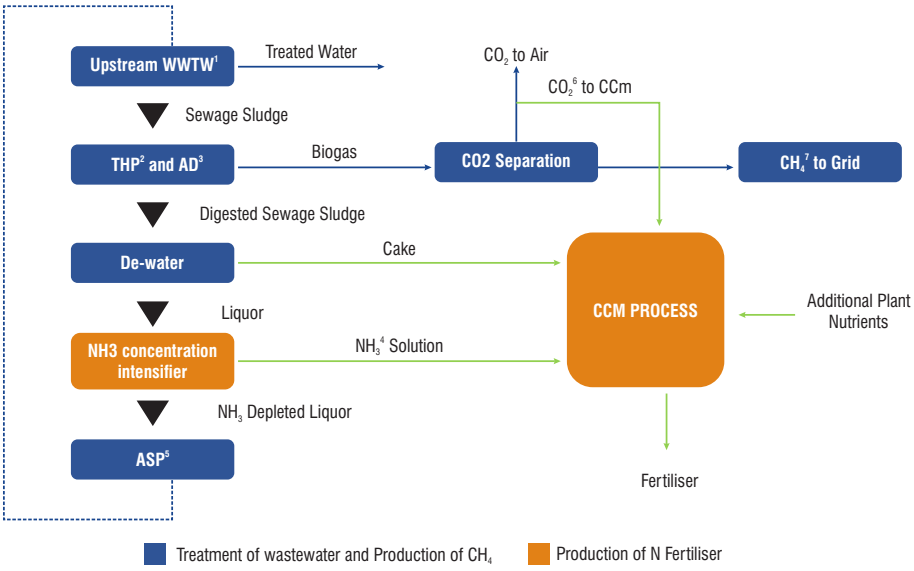


Figure 3: CCm's sustainable fertiliser production process

Results

CCm's process equipment has been commissioned to demonstrate sustainable fertiliser production. Ongoing efforts are focused on recovering CO_2 and ammonia to enhance the process' sustainability. The collaboration between STW and CCm Technologies persists beyond the project as they explore the impact of CCm's technology on decarbonising wastewater and water treatment systems. Current trials involve testing various fertiliser formulations to demonstrate the plant's operability and the advantages of adopting different formulations.

CCm technologies has conducted additional modelling to support analysis and make decisions regarding future production schedules based on energy, carbon benefits, and market size. Extensive work has been carried out on resource recovery, particularly concerning process flow diagrams for CO_2, ammonia, and heat recovery. CCm and STW are actively developing these innovative solutions as part of ongoing trials.

Future Impact

Following the project demonstration, there is potential for further roll out and partner with resource recovery plants within the water treatment sector. Additionally, CCm's technology is being trialed in the food & agricultural, biogas and biomethane sectors, offering significant potential for future industry adoption and replication.

Note: This demonstration project was funded through, and the case study has been adapted from, the UK BEIS (Department for Business Energy and Industrial Strategy) Industrial Energy Efficiency Accelerator Programme 2018-2021. Severn Trent and CCm Technologies also extended their collaboration to further develop solutions.

1. WWTW- Waste Water Treatment Works, 2. THP- Thermal Hydrolysis Process, 3. AD- Anaerobic Digestion, 4. NH_3 - Ammonia, 5. ASP - Activated Sludge Process 6. CO_2 - Carbon-dioxide, 7. CH_4 - Methane,

SECTION 2

INTERNATIONAL CASE STUDIES: LEADING IEED PRACTICES

International Case Studies: LEADING IEED PRACTICES

2.1 Leading Practice Highlight: Driving Sustainability across UK Aluminium Sector

Background

The aluminium industry is a vital part of the UK manufacturing sector and an essential component of the modern UK economy. Annually, the aluminium sector contributes ~**£10 billion** to the UK's economic landscape and provides employment to **39,000+** individuals across the country[1]. Its significance extends to high-value sectors such as aerospace, automotive, rail, construction, and mass packaging markets. As a lightweight and highly recyclable material, aluminium contributes substantially to the UK's low-carbon economy. Its strategic importance is on the rise as it aligns with the government's green growth ambitions and 2050 net-zero targets.

The Aluminium Federation (ALFED) is the trade association representing a wide spectrum of the UK aluminium value chain including primary and secondary producers, extruders, finishers, distributors, recyclers, aluminium casting, packaging, transport, and architecture & structures producers. The UK aluminium industry including **200+** members and partners of ALFED is committed to sustainability and has set a target of becoming net zero by 2050.

UK Aluminium Sustainability Roadmap to 2050

ALFED has outlined a roadmap aimed at enhancing sustainability within the UK aluminium sector, focusing on three key pillars: a) Decarbonisation, b) Sustainable Sourcing, and c) the Circular Economy. Beneath each of these pillars, ALFED has highlighted critical objectives and actionable steps for the sector's advancement. The following figure provides an overview the key action items under each of these pillars.

3 Pillars of UK Aluminium Sector Sustainability Roadmap		
Decarbonisation	**Sustainable Sourcing**	**Circular Economy**
• **R&D acceleration**: work with government knowledge partners & innovators • **Capex support**: Financial support and tax breaks need to enable investment in low-carbo, energy and water-efficient, UK-based manufacturing facilities	• **Traceability**: Best practice standards • **Domestic supply chain development** • **Skills development**: work with industry, universities and other knowledge partners • **Diversity and inclusion**: boosting the proportion of women in the sector • **Social Engagement:** for driving CSR and voluntary initiatives	• **Closed-loop supply chain development**: drive alloy innovation and domestic capacity • **Whole-life design innovation**: recycling into the whole-life design • **National recycling strategy**: Support national reuse, remanufacturing and recycling strategy

Figure 4: Pillars of UK Aluminium Sustainability Roadmap

A. Decarbonisation

In the UK, primary aluminium production relies on hydroelectric power, making the UK aluminium sector highly carbon and resource-efficient. Furthermore, there is currently no hazardous waste sent to landfill. Drosses and slags are converted into pure salts, utilised in melting furnaces, and potash (used as fertiliser), while aluminium is recycled. Therefore, the focus of the UK Aluminium sector on decarbonisation revolves around (i) importing the lowest-carbon primary aluminium and (ii) maximising the utilisation of end-of-life aluminium.

Key actions to support decarbonisation:

- **Accelerating R&D:** Develop policies and initiatives that promote the transformation of end-of-life aluminium into semi-fabricated and finished products within the UK. This involves investing in R&D to advance additive manufacturing,

1 The Aluminium Industry in the UK Report 2022 (ALFED)

create recycling-friendly alloys, and design sensing and sorting systems capable of segregating alloys from mixed scrap materials.

- **Capital Expenditure Support:** Collaborate with the government and knowledge partners to establish financial incentives and tax incentives that facilitate investments in low-carbon, energy-efficient, and water-efficient manufacturing facilities located in the UK.

B. Sustainable Sourcing

Brexit and the COVID pandemic have given the UK aluminium sector a unique opportunity to restructure and rebuild key supply chains. This presents an ideal moment to prioritise sustainable sourcing of primary aluminium and semi-fabricated goods that the UK currently imports. ALFED aims to help the aluminium sector capitalise on this opportunity by providing frameworks and support to streamline processes, promote collaboration throughout the value chain, address skill gaps, and enhance workforce diversity.

Key actions for sustainable sourcing include the following:

- **Traceability:** Support members in implementing leading traceability standards that address environmental and social concerns, such as the Aluminium Stewardship Initiative (ASI) and Chain of Custody Standards.
- **Domestic supply chain development:** Promote ongoing development of the UK's aluminium value chain, partnering with other trade associations like Make UK and the Society of Motor Manufacturers and Traders.
- **Skills development:** Collaborate with industry, universities, and other knowledge partners to create programs that expand the UK's skill base, facilitating the expansion of domestic capabilities across the aluminium value chain.
- **Diversity and inclusion:** Collaborate with knowledge partners and industry to foster diversity within the aluminium workforce, including efforts to increase the share of women in the sector.
- **Social engagement:** Establish a best-practice framework for driving corporate social responsibility (CSR) and voluntary initiatives that enable members to contribute to more socially conscious supply chains.

C. Circular Economy

A staggering **75%** of aluminium ever produced remains in active use, and the production of recycled aluminium consumes ~**5%** of the energy required for primary aluminium. The UK stands as a global leader in aluminium recycling, generating an estimated **1.4 million tons** of aluminium scrap annually. Out of this, **500,000 tons** are currently exported. ALFED's objective is to optimise the utilisation of recycled aluminium within the industry and supply chains, consequently reducing scrap exports by **50,000 tons** annually and achieving a **90%** increase in domestic recycled aluminium usage.

Key actions for the circular economy:

- **Closed-loop supply chain development:** Collaborate with industry stakeholders and knowledge partners to drive alloy innovation and encourage domestic capacity in re-processing and semi-finishing.
- **Whole-life design innovation:** Collaborate with knowledge partners and application-specific experts to integrate aluminium recycling into the entire product life cycle design. This involves incorporating aluminium recycling in initial design phases, replacing materials that are challenging to recycle, and enhancing product recyclability through improvements and reutilisation.
- **National recycling strategy:** Support the government in formulating a national strategy for reuse, remanufacturing, and recycling to curtail aluminium scrap exports and promote the domestic utilisation of recycled aluminium.

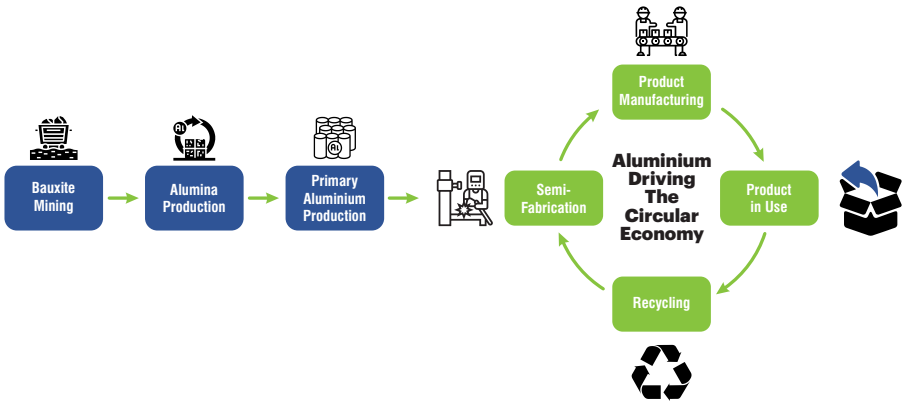


Figure 5: Circular Economy in UK Aluminium Sector

SECTION 3

NATIONAL CASE STUDIES:

Leading IEED Practices

National Case Studies:
LEADING IEED PRACTICES

3.1 Superlative Utilisation of Green Energy in Cement Production

Introduction

Udaipur Cement Works Limited (UCWL) is a publicly listed company incorporated on March 15, 1993, with its registered office located in Udaipur, Rajasthan. UCWL operates as a subsidiary of JK Lakshmi Cement Limited (JKLC), a well-established name in the Indian Cement Industry, with an annual turnover of ~**INR ~5100 Crores (GBP ~510 million)** during Financial Year 2021-22.

The core philosophy of the company is rooted in sustainable growth and a developmental framework aimed at creating a brighter future. UCWL operates an integrated cement manufacturing unit with a capacity to produce **2.2 million tons per annum (MTPA)** of cement. Sustainability is deeply embedded in the company's daily business operations, guided by an Integrated Sustainable Development Policy that structures its systems.

In alignment with the imperative of addressing climate change and the commitments made at COP26 by the nation, UCWL currently meets over **45%** of its total electricity demand from green renewable sources, specifically solar and Waste Heat Recovery Systems (WHRS). In the fiscal year 2021-22, the company expanded its solar power generation capacity by **4.35 MW**, in addition to the existing **10.1 MW** to a total of **14.45 MW**. UCWL has harnessed ~**100,000 MW** of green energy, resulting in the mitigation of ~**85,000 tons** of CO_2 emissions. This reduction is equivalent to the environmental impact of **34 lakh** trees mitigating CO_2 emissions annually over the past two fiscal years. In its commitment to responsible resource management, the company has undertaken significant water conservation efforts, maintaining a water-positive status of approximately twice its consumption and saving ~**3.6 lakh** tons of virgin-natural resources by replacing them with waste-derived raw materials in its production processes.

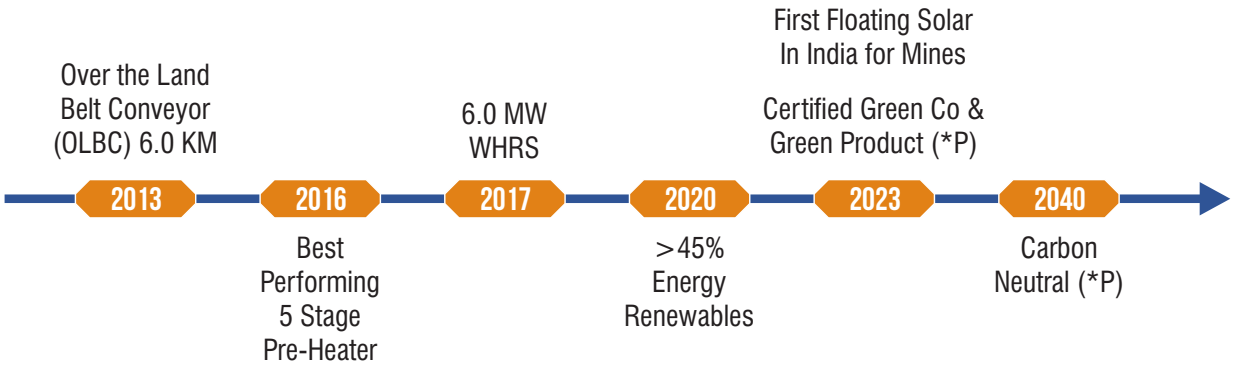


Figure 6: Major milestones achieved and planned by UCWL

Specific Energy Consumption (SEC)

Over the last three years (2020-2023), through various energy efficiency improvement initiatives, UCWL has reduced its electrical specific energy consumption (kWh/ton) by ~**5%** and its thermal energy consumption (kCal/kg of clinker) by over **8%**. Details of the improvement in SEC are provided in Figure 7 below:

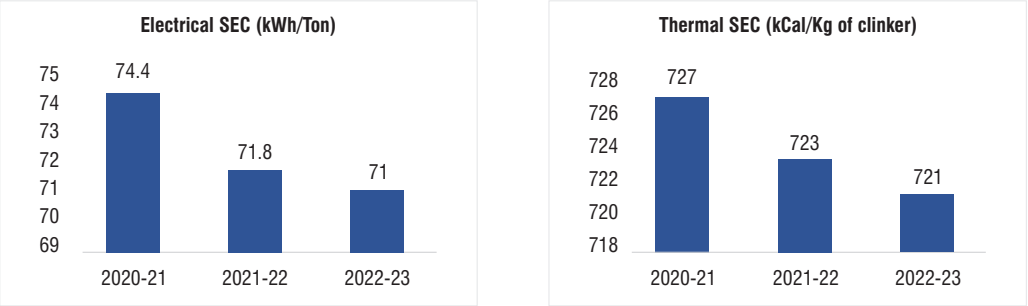


Figure 7: Improvement in UCWL's SEC between 2020-2023

Transition from Grid Electricity to Renewable Energy

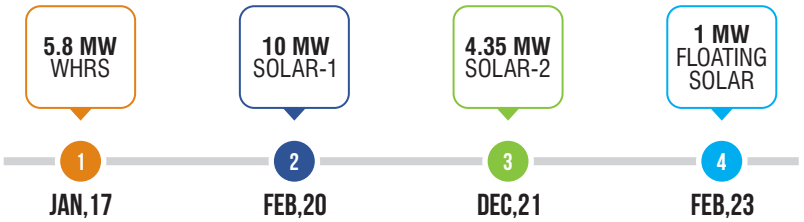


Figure 8: Progressive Journey (Green Energy)

Earlier, electrical energy (primarily reliant on grid supply) constituted **15%** of UCWL's overall energy needs. In a concerted effort to adopt eco-friendly practices and reduce reliance on grid power, the plant devised a strategic plan aimed at reducing its grid electrical power dependence to **50%** of the total consumption. This transition was achieved through the installation of Waste Heat Recovery Systems (WHRS) and Solar Photovoltaic (PV) units, increasing UCWL's renewable energy resources and elevating share of green power to ~**50%**. Currently, the plant has a capacity of **6 MW** for WHRS and **15.45 MW** for Solar PV, reflecting a substantial shift towards renewable energy sources.

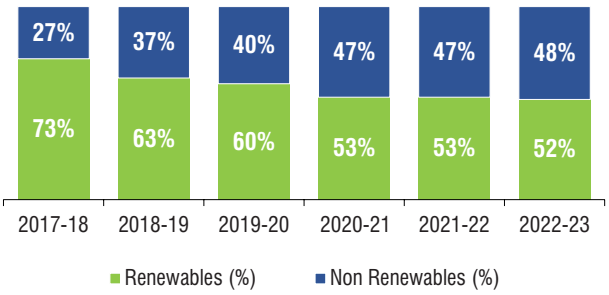


Figure 9: UCWL's energy trend over the years

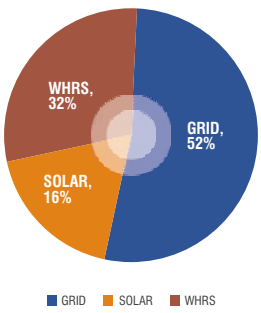


Figure 10: Electrical Energy Mix (%)

To maximise the capacity of WHRS (after modification and improvement efforts) following tasks were undertaken:

- Decreased pressure drop in Air Quenching Cooler (AQC) boiler outlet duct.
- Enhanced pressure and flow in the AQC boiler by regulating the revolutions per minute (RPM) of cooler fans through cascading PID loops with boiler inlet temperature.
- Transitioned kiln feed stage from 5th stage feeding to 4th stage feeding using a splitter damper in the air slide.
- Achieved auxiliary consumption reduction to below 4%.

Further, plant operations have also been aligned to availability of solar energy during daytime to maximise utilisation, keeping night hours for maintenance activities.

Floating Solar Grid

Floating solar grids were deployed on mining pits to further share of renewable energy in the total energy consumption. This innovative floating solar setup marks a pioneering achievement in the Indian cement industry, having received approval from Directorate General of Mines Safety (DGMS), and it also stands as the first floating solar installation in the state of Rajasthan.

- ~8,000 m3/ year of avoided water evaporation
- ~1,000 ton/ year of carbon savings
- ~7,200 sq.mtr of land area savings
- ~1.5 Lakhs trees to be saved per year
- ~ INR 25 Cr (~GBP 2.5 million) worth of financial savings

Figure 11: Key highlights of benefits of floating solar project at UCWL's mining pits

Use of Emerging Technologies

UCWL has consistently taken initiative in adopting new and emerging decarbonisation technologies. Following are few technologies adopted by the plant:

IEED Technologies	Status
IOT Sensors for real-time condition monitoring of equipment's	Implemented
Real-time belt scanning system in OLBC	Implemented
Online Particle Size Distribution system for mills	Implemented
AI-based "Advanced Process Control Suite" for kiln & mills optimization	Implemented
Use of AI- ML enabled Maintenance & Equipment Feedback	Being explored

Figure 12: Emerging Technologies adopted by the plant

Measures adopted to mitigate GHG emissions

The concerted efforts undertaken by the plant have yielded tangible resulted in reduction of GHG emissions from **593** to **562 kg CO_2/ Tonne Cement equivalent** during the 2018-21 period. This was achieved through a combination of strategies, including a **20%** increase in blended cement usage, a rise in renewable energy (RE) utilisation, enhanced energy efficiency, greater reliance on alternate fuels, and a substantial **15%** reduction in coal consumption.

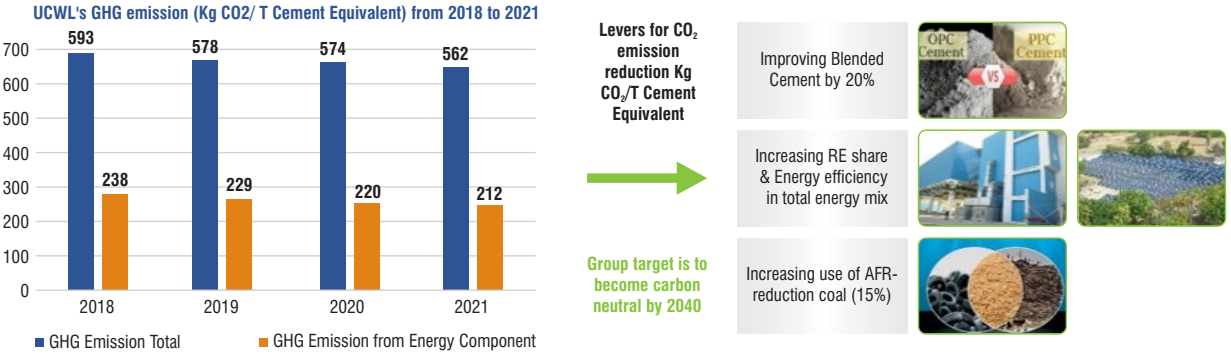


Figure 13: Measures adopted by UCWL to mitigate GH emissions

3.2 Copper Insert Collector Bar for Energy Reduction in Hindalco Smelter

Hindalco is actively working towards achieving it's ambitious target to be net-zero in carbon emissions target by 2050. The increasing energy costs have made the aluminium industry to explore various methods for reducing specific energy consumption. The Mahan smelter unit operated by Hindalco has adopted AP36 cell technology, running at ~**366 kA**, with a specific energy consumption of **13.5 DC kWh/kg** of Al. Hindalco's smelters work closely with the Aditya Birla Science & Technology Center (ABSTC), the corporate R&D center of the Aditya Birla Group, to enhance the energy efficiency and productivity of their smelting operations.

Figure 14: Copper Insert Collector Bar

One recent focus area in the global aluminium smelting industry for energy reduction is the Copper-insert Collector Bar (CuCB). CuCB effectively reduces the cathode voltage drop and significantly decreases horizontal currents, which are critical for Magneto hydrodynamic[1] (MHD) stability in the cells. While CuCB is intuitively preferred for high kA cells, known for their heat-dissipating properties, however, prolonged power outages can pose challenges for these cells.

Mathematical models have demontrated their effectiveness in addressing numerous challenges during the cell design phase. The team at ABSTC has developed and validated 3D models that encompass various physical aspects of the smelting process. These models were utilised to predict and analyse the thermal profile, voltage and current distribution, magnetic field, and molten fluid flow for both existing cells and those equipped with CuCBs.

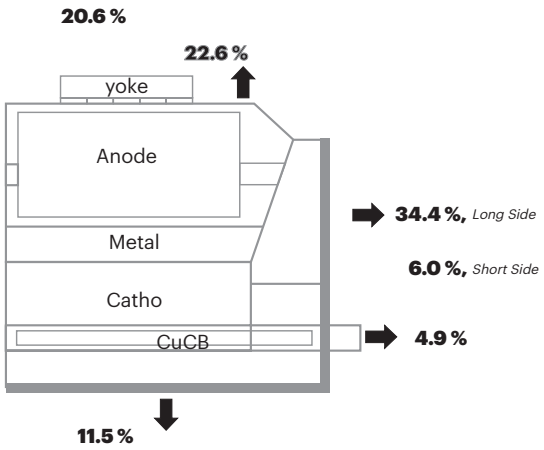


Figure 15: Representative diagram for application of copper insert collector bars (CuCB) in smelting process

CuCBs offer a substantial reduction in cathode voltage drop as compared to the conventional steel collector bars at a consistent line amperage. The inclusion of copper enhances the electrical conductivity of the collector bar, resulting in decreased horizontal current within the molten metal. This improvement positively impacts the MHD stability of the cell and reduces the overall flow velocity of molten aluminium, consequently enhancing current efficiency. Improved MHD stability creates the potential to narrow the inter-electrode gap without compromising current efficiency. Additionally, modifications were made to the cell lining to ensure temperature isotherms and freeze profiles are maintained with reduced heat generation, ensuring similar performance during power outages.

Based on this innovative design, a pilot cell was initiated in 2018, demonstrating excellent performance with a reduction in specific energy consumption by **300 kWh** per ton. Notably, the cell was able to function during a four-hour power outage. Building upon this success, the implementation of this technology is now underway in all cells at both the Mahan and Aditya smelters of Hindalco.

1 Magneto hydrodynamic stability refers to the stability of electrically conducting fluids (such as plasmas or liquid metals) in the presence of magnetic fields. It investigates how disturbances or perturbations in the fluid flow interact with magnetic fields, leading to either stable or unstable behavior.

SECTION 4
FROM THE ARCHIVES

From the Archives

4.1 From the Archives: Timeless Gems to Revive Your Reading List!

Policy Roundtable on Enabling Circular Economy and Resource Efficiency in Aluminium and Cement Sectors: Utilising Spent Pot Lining (SPL) and other waste products of Aluminium Sector

The ASPIRE Programme in collaboration with Bureau of Energy Efficiency (BEE) organised a policy roundtable on **Enabling Circular Economy and Resource Efficiency in Aluminium and Cement Sectors: Utilising Spent Pot Lining (SPL) and other waste products of Aluminium Sector** on June 9th, 2023, at the Bureau of Energy Efficiency office, New Delhi.

Photograph from Policy Roundtable Discussions

The objectives of the policy roundtable is given below:

- Deliberate and explore the potential of utilising Spent Pot Lining (SPL) from the Aluminium sector in the context of circular economy. This includes identifying and evaluating suitable approaches and technologies for its utilisation.
- Identify policy interventions required to facilitate safe and environmentally friendly disposal or reprocessing of SPL.
- Address challenges associated with SPL management, including its hazardous nature, proper handling, homogenisation, storage, and compliance with regulatory directives.
- Foster collaboration & develop effective strategies for sustainable SPL management, contributing to resource efficiency, energy conservation & reduced environmental impact.

The event witnessed participation from **30+** senior officials from BEE, Jawaharlal Nehru Aluminium Research Development & Design Centre (JNARDDC), Global Cement & Concrete Association India, Dalmia Cement, Vedanta Aluminium, UltraTech Cement, Hindalco Industries, JK Cement, Shree Cement, JK Lakshmi Cement, JSW Cement, ACC Ltd., etc. participated in the policy roundtable.

Key Discussion points included the following:

- SPL, a residual material generated in the primary aluminium smelting industry, offers potential to serve as a valuable alternative raw material for cement & ferro-alloy sectors, due to its high carbon & mineral content.
- Utilising SPL or its derivatives in cement kilns as an alternate fuel and raw material (AFR) offers several benefits including reduction in fuel consumption and nitrous oxide emissions, lower clinker temperature etc. However, it poses certain key challenges such as difficulties in grinding, hazardous cyanide content, and storage issues, etc.
- In addition to SPL, the aluminium sector also generates other waste/ secondary products such as red mud & dross which can be re-purposed for utilisation in the cement sector.
- Addressing the challenge of hazardous from aluminium industries would require adopting a cluster approach and leveraging the role of State Pollution Control Board as facilitators.
- Need to formulate a mechanism to share profits/ costs between aluminium smelting and cement industries to enable circular economy.

Following future interventions / actions were identified during the policy roundtable:

- Establish clear regulations and guidelines for SPL management and utilization in cement industries.
- Mandate minimum percentage utilisation of SPL in cement kilns.

Further details regarding the policy roundtable including the background note, presentations delivered by speakers, and the event summary report can be accessed from the below link:

https://www.ideeksha.in/pages/Policy%20Roundtable%20on%20Enabling%20Circular%20Economy%20and%20Resource%20Efficiency%20in%20Aluminium%20and%20Cement%20Sectors

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