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ENERGY AUDIT, SAVING AND GREEN ENERGY FOR DIE CASTING

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Casting a Greener Future: Decarbonization Strategies for Aluminium Industries

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INTRODUCTION

India holds a prominent position in the global aluminium die-casting industry which is valued at approx. $ 3 billion, serving as a critical supplier to both domestic and international markets. Renowned for its robust manufacturing capabilities and high-quality production standards, the sector significantly contributes to India's export economy while supporting key industries such as automotive, aerospace, and electronics. In India, the industrial sector ranks second only to the power sector in terms of energy consumption. As of 2023, the industrial segment consumes approximately 42% of the country's total energy, with Micro, Small, and Medium Enterprises (MSMEs) accounting for one-fourth of this consumption. The energy mix in India is predominantly reliant on fossil fuels, particularly coal, which meets over 60% of industrial energy demand, while petroleum fuels contribute another 20%. Natural gas, with a modest share of 5%, is primarily consumed by the petrochemical sector as feedstock. This heavy reliance on traditional, carbon-intensive fuel sources has significantly elevated the emissions footprint of the industrial sector. India's industrial emissions are projected to rise from 28% of total emissions in 2020 to 35% by 2040. This underscores the urgency for robust policy actions that go beyond incremental efficiency gains and aim for deep decarbonization of industrial energy use.

A critical strategy in this direction is the regular conduct of energy audits in Industries. Energy audits play a pivotal role in identifying energy losses and proposing efficient practices to optimize energy use, thereby reducing production costs, lowering carbon emissions, and improving overall productivity. These audits are low-hanging fruits that industries can leverage to achieve tangible benefits while aligning with broader decarbonization goals.

Moreover, with the increasing focus on curbing carbon emissions, industries must prepare to comply with evolving regulations, such as the European Union's Carbon Border Adjustment Mechanism (CBAM) for export-oriented sectors. The Government of India has also introduced several financing schemes to support cleaner energy transitions. Organizations like the Alliance for an Energy Efficient Economy (AEEE) are playing a pivotal role by promoting energy-efficient technologies, providing capacity-building support, and advocating for sustainable practices in Maharashtra and beyond. Now is the time for industries to adopt these solutions, reduce their emissions footprint, and lead the way in mitigating climate change.

SCOPING STUDY CONDUCTED BY AEEE IN MAHARASHTRA:

In Maharashtra, AEEE has partnered with the Government of Maharashtra to advance energy efficiency and decarbonization efforts within the MSME sector. Through an extensive scoping study involving in-depth research, stakeholder consultations, and field visits, AEEE identified three potential clusters for intervention, with the Pune aluminium cluster emerging as a key focus area. Additionally, AEEE developed a sector-specific and cross-sectoral technology database highlighting low-carbon levers with significant energy-saving and replication potential.

The Pune aluminium cluster, known for its high energy consumption and considerable carbon emissions, offers an opportunity for transformative change. Preliminary analyses

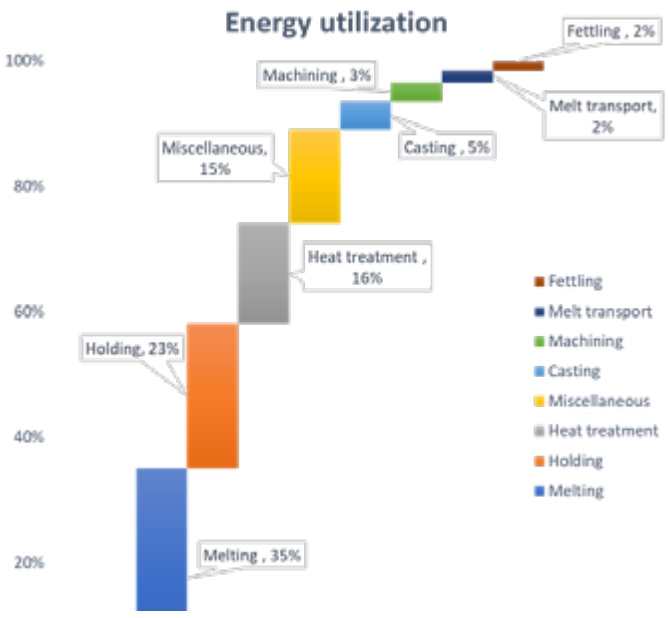

Figure 1: Distribution of energy consumption in Industries

indicate that adopting energy-efficient technologies could result in energy savings of 20-30%, alongside a substantial reduction in carbon emissions. AEEE is actively supporting MSME units within this cluster by providing technical and financial advisory services to facilitate the adoption of these low-carbon solutions. These initiatives are intended to serve as scalable and replicable models for similar interventions across other MSME clusters in Maharashtra and beyond.

LOW CARBON LEVERS FOR DIE CASTING INDUSTRIES:

AEEE has identified a set of advanced technologies that can be implemented in die-casting industries to enhance energy efficiency and reduce carbon emissions. This identification process involved extensive consultations with MSMEs and technology suppliers, ensuring the solutions are both practical and impactful. These technologies were selected based on their significant energy-saving potential and scalability across clusters.

To facilitate industry-wide adoption, AEEE conducted a stakeholder consultation workshop with MSME units in the Pune aluminium cluster. The workshop provided a platform to discuss the identified technologies, their benefits, and implementation strategies. The details of a few selected technologies are as follows:

1. Self recuperative burner: Recuperative burners employ a heat exchanger positioned within the exhaust flue. Exhaust gases leaving the furnace transfer their thermal energy to the heat exchanger, warming the incoming air stream. This preheated air then mixes with fuel, resulting in a more efficient combustion process. Recuperative burners can reduce NOx emissions, save energy up to 30% compared to cold air combustion system, and increase combustion efficiency. Technology costs around Rs 15-25 lakhs with a payback period of less than 1.5 years.

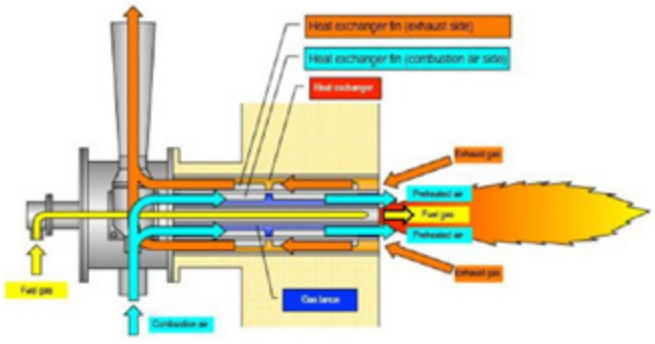

Figure 2:Working of recuperative Burner

2. VFD enabled screw air compressor with permanent magnet motor: Existing old reciprocating compressors can be replaced with PM motor-based screw compressor. This works on permanent magnet motor which under full load condition, can supply the maximum air output under the minimum energy consumption, and when the load rate is lower by 20%, can still guarantee the efficiency. SEC reduction by 40% along with reduction in maintenance cost and break-down time by 50% can be achieved. The payback period for this compressor is less than one year and price varies as per size. The SEC of this compressor can go up to 0.16 kw/cfm.

Figure 3: Screw air compressor

3. Thermo Ceramic coating: Thermo Ceramic Coating is a technology specifically designed to enhance heat retention and distribution. This coating when applied to industrial equipment creates a thermal barrier around it preventing heat loss thus maintaining optimum temperatures in the factory while also cutting down energy costs. Thermo Ceramic Coating can work from -18 0C to 1800 0C. It can reduce heat loss up to 20% which can lead to reduction in fuel consumption. Its payback period is up to 1 year and has a life of around 5 years.

IMPORTANCE OF ENERGY AUDIT IN MANAGING THE PLANT OPERATIONS

Energy audits are a critical driver for industrial decarbonization, serving as a foundational tool to systematically identify inefficiencies and unlock energy-saving opportunities. Conducting energy audits is crucial for pinpointing areas of energy wastage and suggesting measures to streamline energy consumption, which helps cut production costs, minimize carbon footprints, and boost overall operational efficiency. These audits are low-hanging fruits that industries can leverage to achieve tangible benefits while aligning with broader decarbonization goals. Energy audits are particularly critical in industries like aluminium die-casting, where energy-intensive processes such as melting and holding consume significant energy. Regular energy audits help pinpoint inefficiencies in process, such as poor insulation, suboptimal burner settings, or excessive idle running times, and propose targeted solutions. The benefits of energy audits extend beyond environmental impact, offering significant financial advantages. Industries that implement energy audit recommendations often experience a reduction in energy costs by 10-30%, depending on the scale of inefficiencies addressed. For example, audits in the aluminium die-casting sector have revealed that optimizing furnace efficiency through improved insulation and waste heat recovery can lead to energy savings of up to 20%. Additionally, switching to energy-efficient motors and compressed air systems has demonstrated savings of 10-15% in auxiliary energy consumption. Advanced measures, such as transitioning to renewable energy sources and

incorporating digital energy monitoring systems, further amplify the benefits. Industries often benefit from the ancillary advantages of energy audits, including improved operational reliability and compliance with national and international standards. For example, energy audits can support alignment with regulatory frameworks like the Perform, Achieve, and Trade (PAT) scheme in India and global carbon reduction mandates. Energy audits should be considered the best approach to reducing losses because they provide a systematic method to uncover hidden inefficiencies, quantify their impact, and recommend actionable solutions. By following a structured approach to implementing energy audit findings, industries not only achieve immediate financial benefits but also build resilience against rising energy costs, enhance their competitiveness and carbon compliance requirements.

LEGAL OBLIGATIONS FOR CONDUCTING ENERGY AUDIT IN INDIA

The legal framework for conducting energy audits in India is governed by the Energy Conservation Act, 2001, enforced by the Bureau of Energy Efficiency (BEE). As per the EC Act, energy audits are mandatory for Designated Consumers (DCs), which include energy-intensive industries covered under Pat scheme as well as industries which meets the threshold limits mentioned by BEE for each energy intensive sectors. The BEE (Manner and Intervals of Time for Conduct of Energy Audit) Regulations, 2010 stipulate that every Designated Consumer must conduct an energy audit through an accredited energy auditor within 18 months of the notification issued by the Central Government. Subsequent audits are required every three years.

The regulations outline a structured methodology for energy audits, including data verification, performance measurements, and the development of cost-benefit analyses for recommended measures. The findings of the energy audit must be submitted in a prescribed format to the management of the designated consumer, ensuring accountability and transparency. Non-compliance with these legal obligations can attract penalties under the Act. By adhering to these regulations, industries not only comply with legal mandates but also unlock significant energy savings and contribute to the national goal of reducing carbon emissions.

SCHEMES SUPPORTING ADOPTION OF LOW CARBON LEVERS IN INDUSTRIES

The Government of Maharashtra and the Government of India have introduced various schemes to support MSMEs in technology upgradation and green projects. Recognizing the need for accessible financial resources, AEEE has compiled a list of financing schemes available at both central and state levels for MSMEs across different sectors. These schemes aim to encourage the adoption of energy-efficient technologies and sustainable practices, providing the necessary financial impetus for industries to transition toward a greener future. Below is a brief list of such schemes that MSMEs can avail themselves of:

S. No.	Name of scheme	Scheme Brief	Implementing agency
1	The Package Incentive Scheme (PSI-2019) Under the Maharashtra Industrial policy, 2019	• Capital Subsidy for Technology Upgradation (5% subsidy for technology upgradation, capped at ₹25 lakhs) • Subsidy for Cleaner Production (25% subsidy limited to ₹5 lakhs. • Energy Efficiency Improvement (50% subsidy limited to ₹5 lakhs) • Interest Subsidy (Available to new units for term loans used to acquire plant and machinery, capped at 5% of interest paid)	Directorate of Industries, Government of Maharashtra
2	Credit Guarantee Trust Fund for MSMEs (CGTMSE)	Provides credit guarantee to financial institutions for loans extended to MSMEs without collateral.	Ministry of MSME and SIDBI
3	MSME Sustainable (ZED) Certification Scheme	ZED certification encourages MSMEs to adopt energy-efficient technologies, reducing emissions and costs while improving access to government schemes and concessional financing to ZED certified MSME units, such as SIDBI's SMILE (8.10%), SBI SME loans (0.50% reduction), Bank of Baroda Capex loans (1% reduction).	Ministry of MSME

4	SIDBI Make in India Soft Loan Fund for MSMEs (SMILE)	Used for investment in plant & machinery; This scheme provides a soft loan in the nature of quasi-equity. It also provides term loans on relatively soft terms to MSMEs. It also provides loans to the existing MSMEs	SIDBI
5	SPICE (Supporting Payment Infrastructure for Credit Enhancement)	It is a Credit Linked Capital Subsidy scheme. A maximum of INR 50 lakhs is admissible under the scheme with 25 % subsidy only for plant and machinery. Under the Scheme, projects costing more than INR 50 Lakhs will also be eligible, but subsidy shall be limited to INR 12.5 Lakhs	Ministry of MSME

Table 1: Summary of Financing schemes

DEMAND AGGREGATION AND ECONOMY OF SCALE

Demand aggregation is a powerful mechanism to achieve cost efficiency and promote the adoption of standard energy-efficient technologies in industries. By pooling the demand for specific technologies across multiple MSME units, associations like ALUCAST can leverage collective purchasing power to negotiate better prices and terms with technology providers. This approach not only reduces the cost burden on individual MSMEs but also ensures uniform adoption of high-quality, energy-efficient solutions across the cluster. Additionally, demand aggregation simplifies supply chain logistics, facilitates bulk procurement, and fosters partnerships with technology suppliers.

There are few successful cases in MSME clusters where demand aggregation of few technologies have been done by Energy Efficiency Services Limited (EESL) and achieved a price reduction of up to 25% from the market price through bulk procurement. ALUCAST's role as a facilitator in demand aggregation is crucial for driving large-scale deployment of energy-efficient technologies, making them accessible and economically viable for MSMEs while accelerating the sector's transition toward sustainability.

CONCLUSION

Decarbonizing the aluminium die-casting industry is a critical step toward achieving India's energy and climate goals. Adopting a multi-faceted approach that combines technical solutions, financial support, and collective action can significantly enhance the sector's competitiveness while reducing its environmental impact. Associations like ALUCAST can play a pivotal role in facilitating demand aggregation, making cutting-edge technologies more accessible to MSMEs. To meet India's national and global sustainability commitments, timely action is crucial.

The industry must act swiftly to stay ahead of regulatory frameworks and align with international climate agreements. Additionally, adopting innovative business models like Energy Service Companies (ESCO) can accelerate the uptake of low-carbon solutions, enabling faster adoption of energy-efficient technologies and decarbonization strategies. By embracing these strategies, the aluminium die-casting industry can become a model for sustainable industrial practices, fostering resilience and leadership in the global transition toward a low-carbon economy. The time to act is now, and with collaborative efforts, the sector can unlock a future that balances economic growth with environmental stewardship.

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