Pathways for Energy Efficiency and Decarbonisation in the Indian Aluminium Industry

Under Accelerating Smart Power and Renewable Energy in India (ASPIRE) Program

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Aluminium Sector in India

India's Production & Market

- 2nd largest producer;
- Primary aluminium accounts for 70% of total Aluminium production in India.

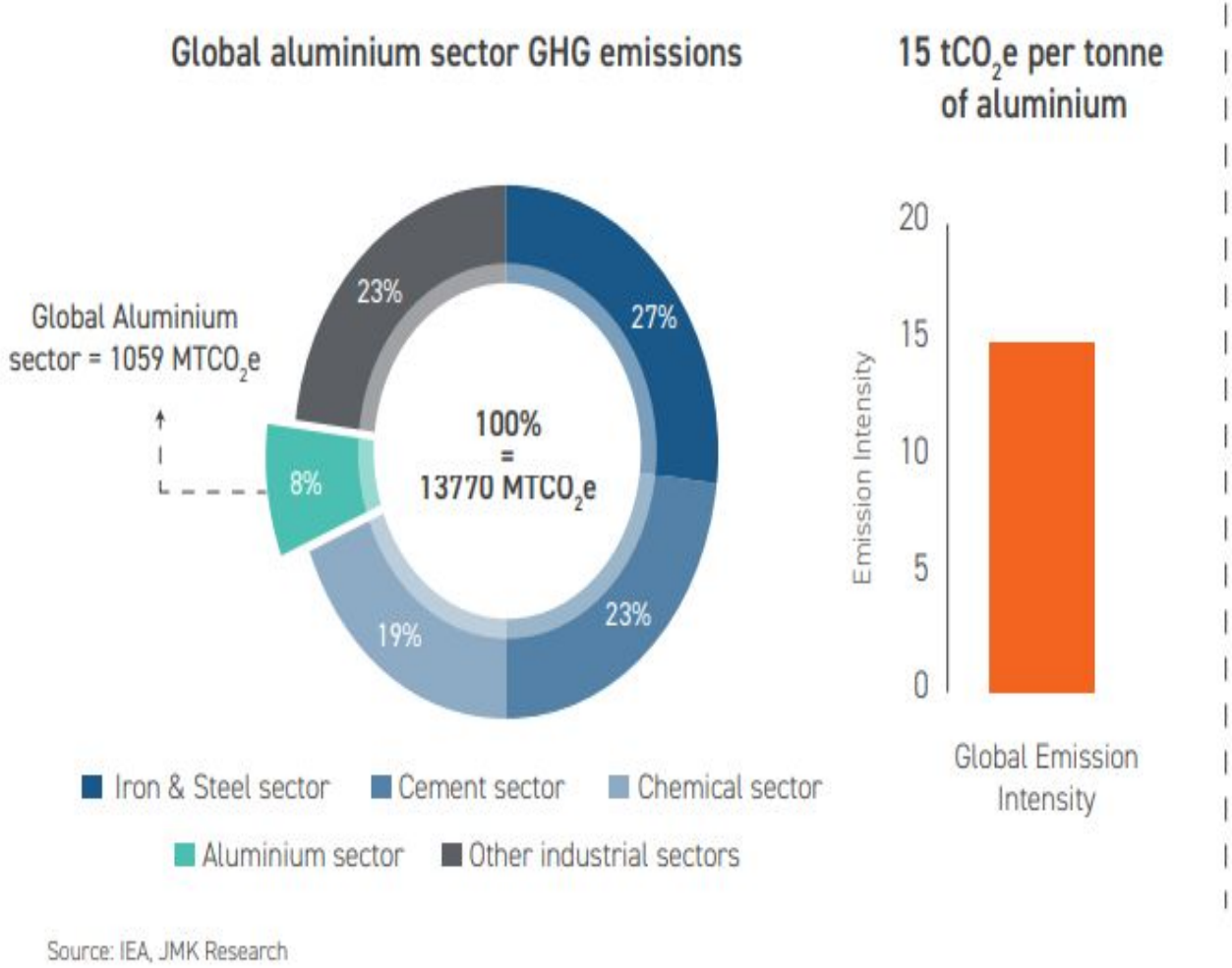
Per Capita Consumption

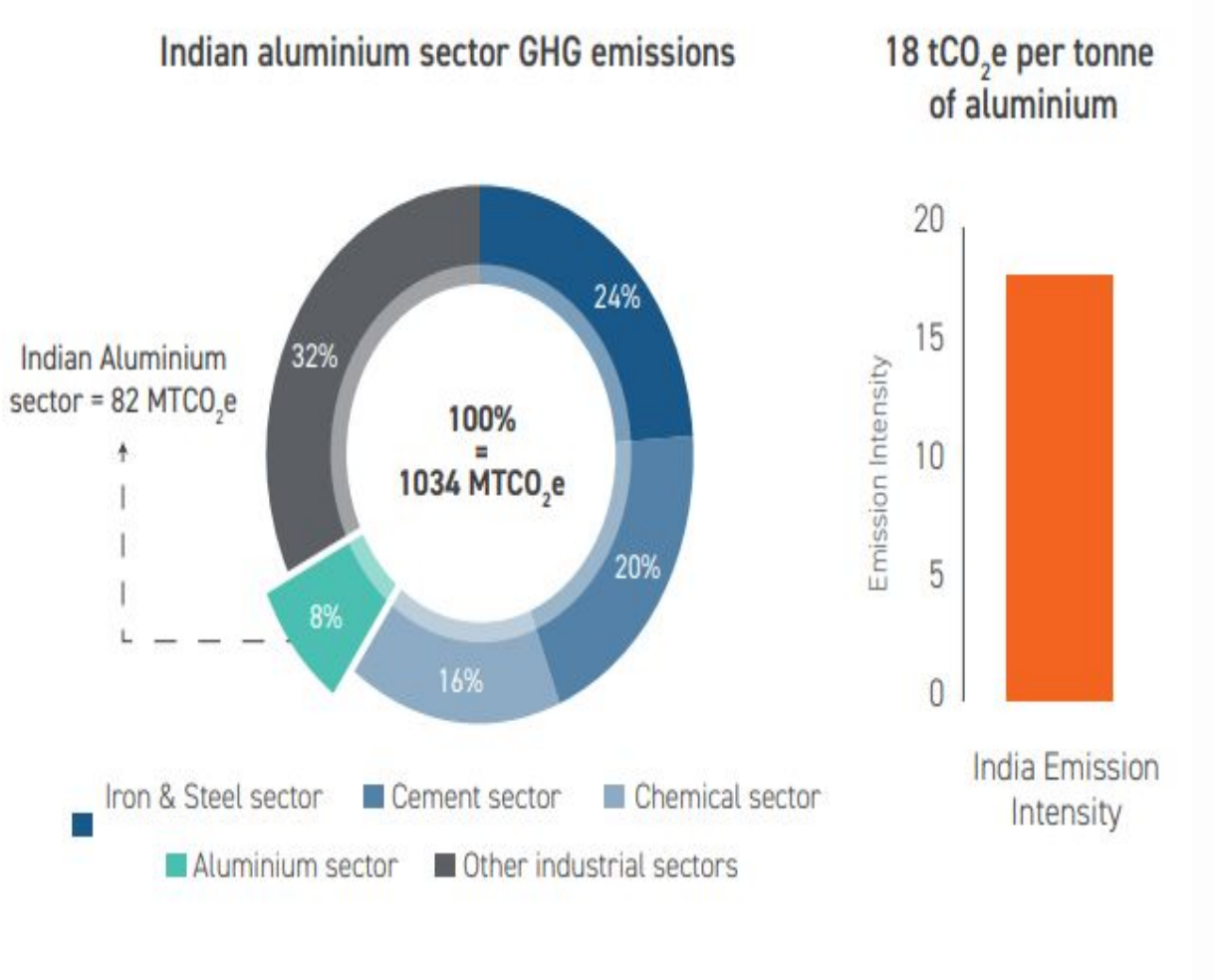
Economic Contribution

Key Players

Why Decarbonising is hard to abate sector like Aluminium Industry

GHG Emissions from Aluminium: A Global and Indian Perspective



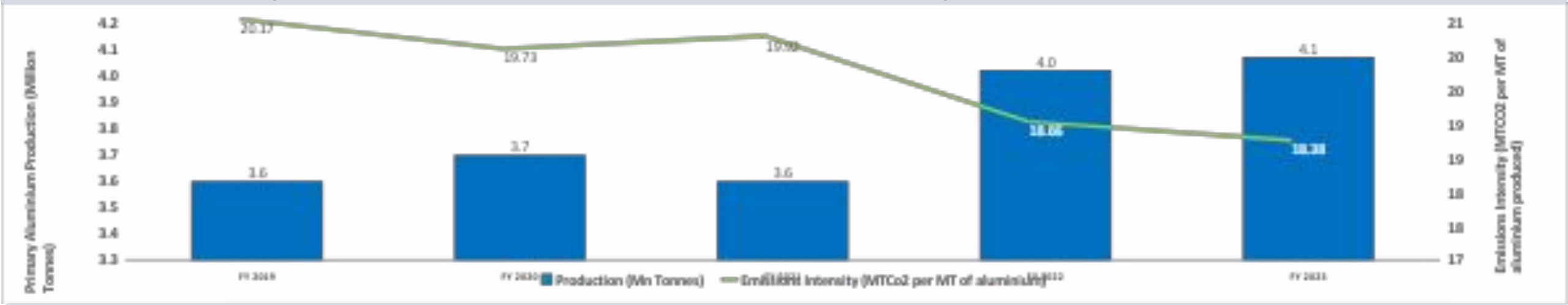


Source: IEA, JMK Research

Source: https://jmkresearch.com/wp-content/uploads/2025/04/Green-Power-Procurement-by-Aluminium-Sector-in-India_JMK-Research.pdf

Emission intensity

Primary Aluminium annual production, and emissions intensity of Indian Producers (FY 2019-2023)



Emission intensity of India and global in tCO_2e/t

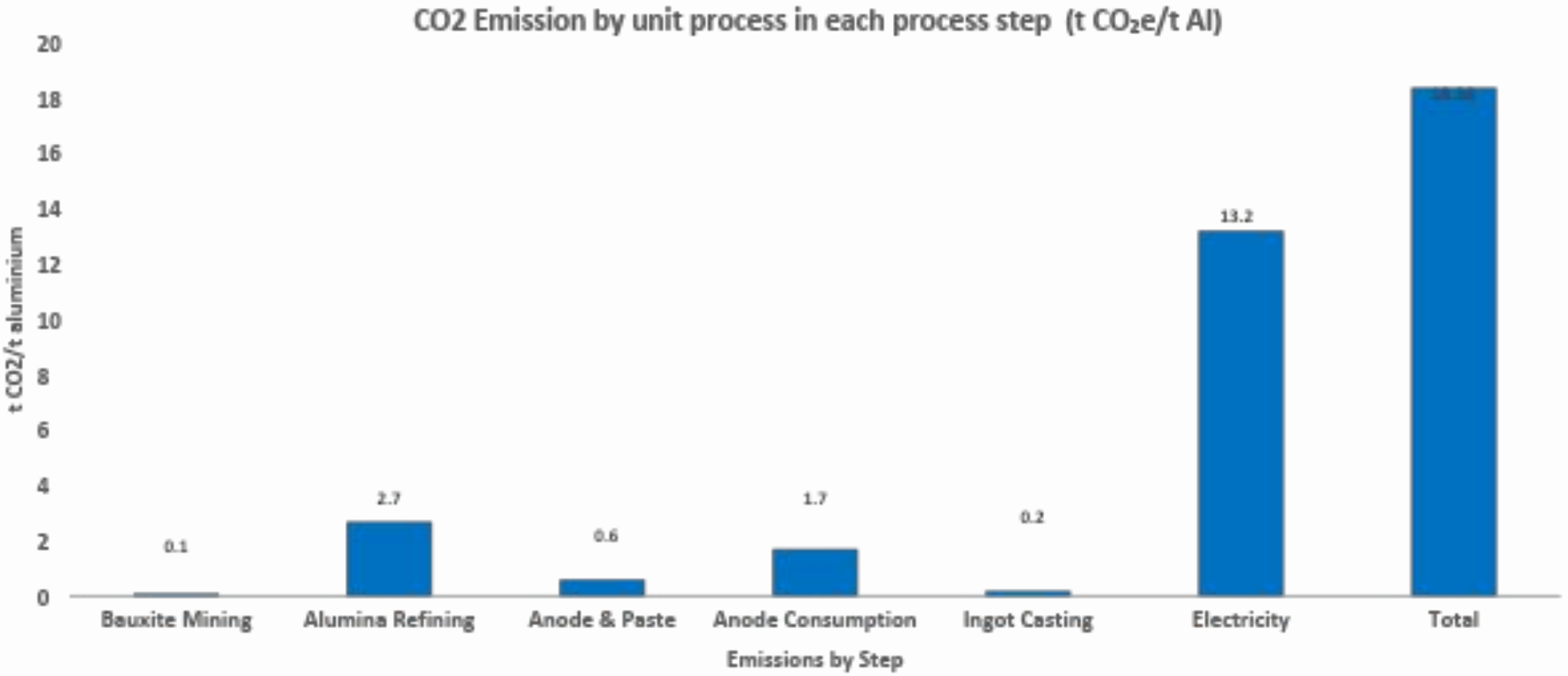
	INDIA	GLOBAL
Lowest	~16.2	~1.6
Average	~18	~15

Emission intensity measures CO_2 emissions per tonne of aluminium produced. Norsk Hydro leads globally with the lowest intensity (~1.6 tCO_2e/t).

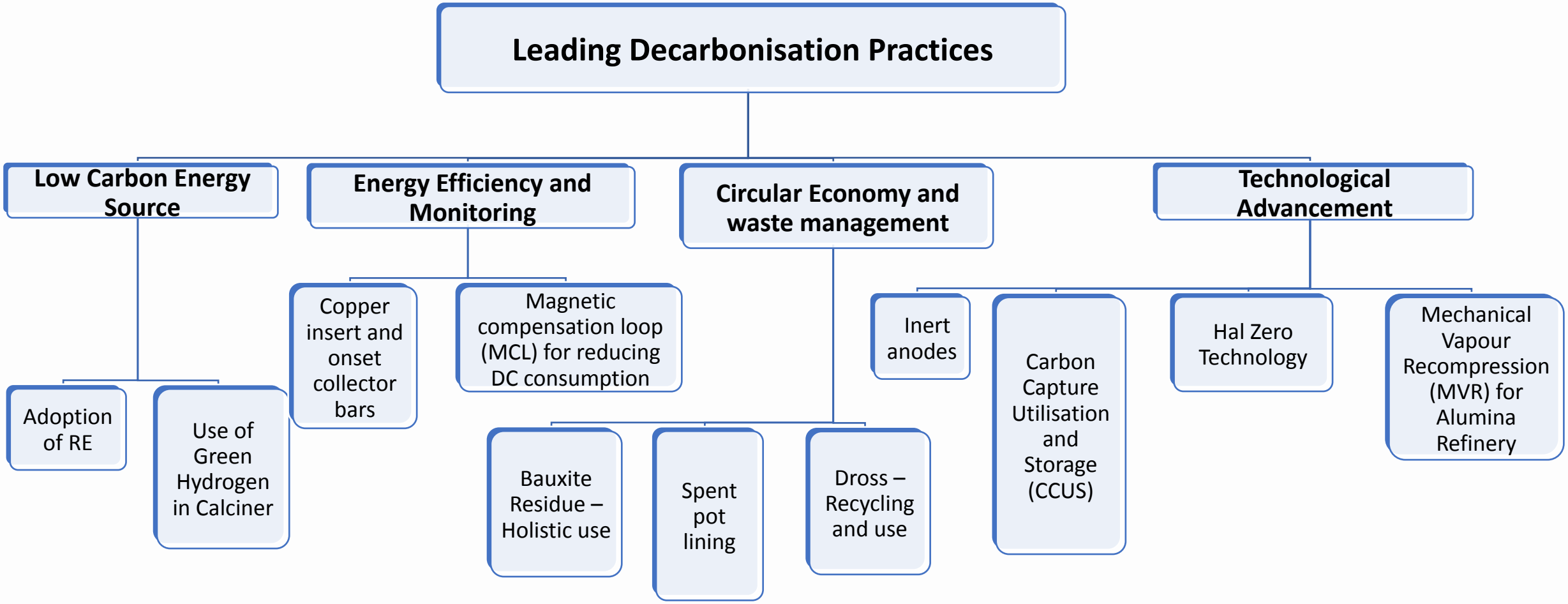
Indian smelters have the highest global emission intensities, with the best performing at ~16.2 tCO_2e/t, compared to a national average of ~18 tCO_2e/t, but still higher than the global average of ~15 tCO_2e/t. Other global smelters, like Alcoa and Rio Tinto, benefit from low-emission power sources.

Source: Analysis based on sustainability reports of primary aluminium producers in India.

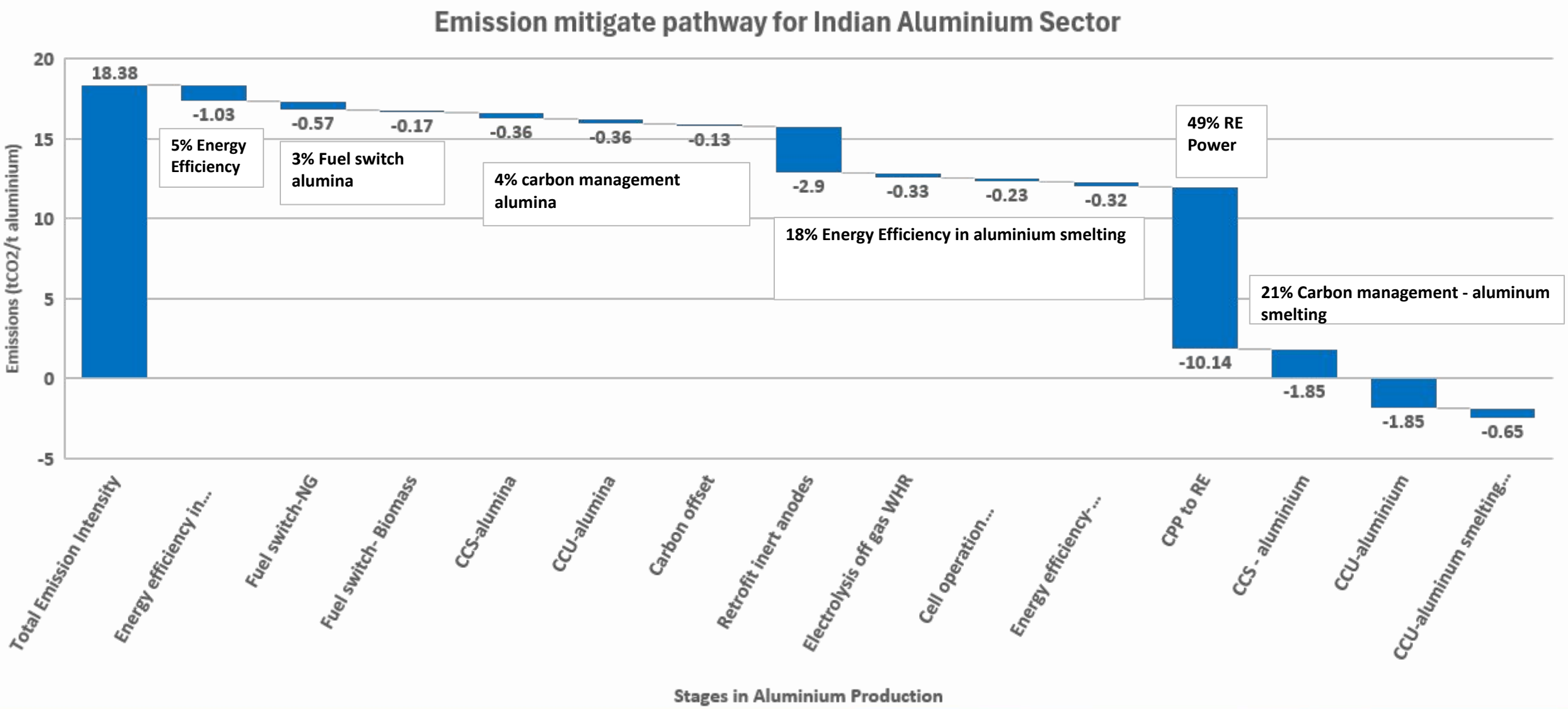
CO2e Emissions in Unit Process (India)



Leading Decarbonisation practices



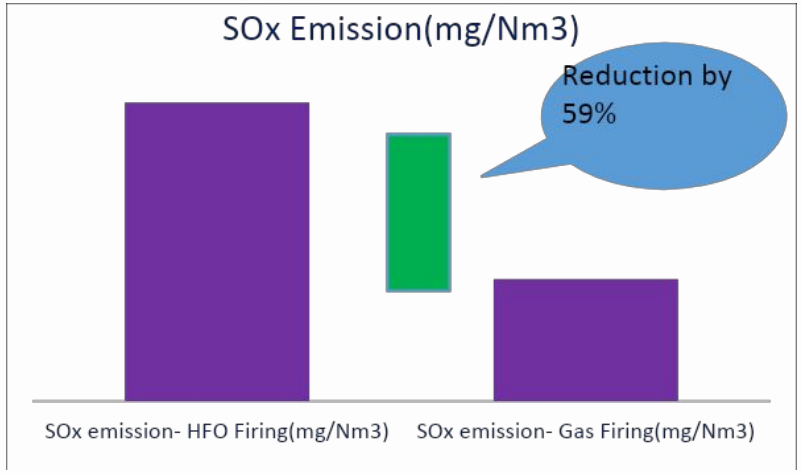
Emission Mitigation Pathway for Indian Aluminium Sector

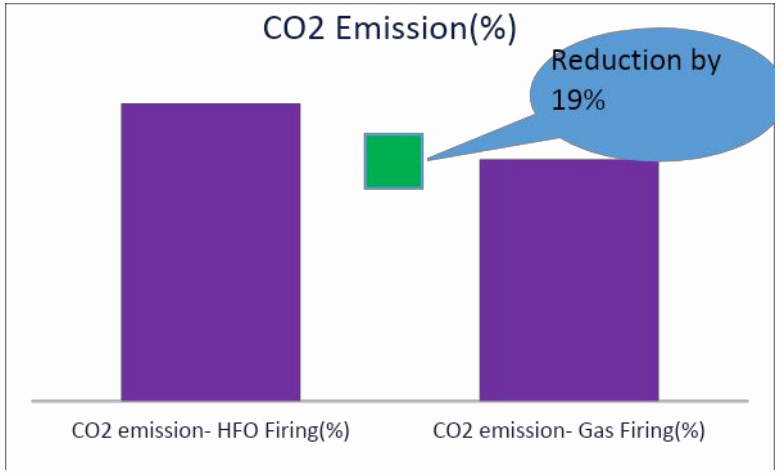


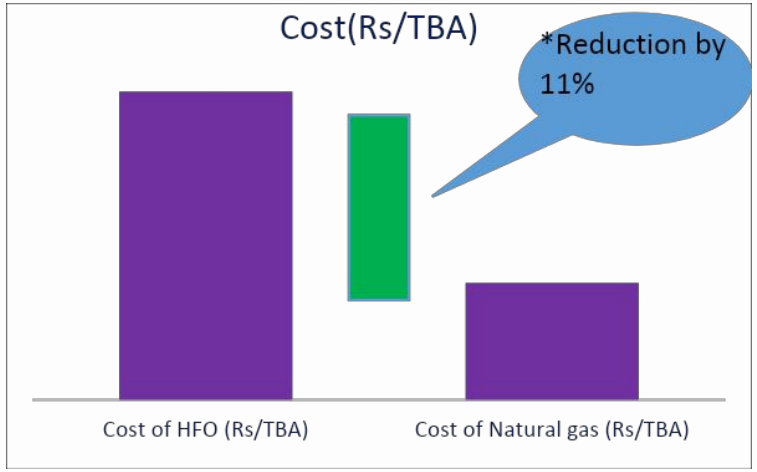
Case Study: Hindalco Industries Limited

- **<u>ABF-1 HFO to Natural Gas Conversion:</u>**
- Conversion of existing HFO based Firing system to Natural gas-based firing system in Anode Baking Furnace
- **First Aluminium Smelter in India**
- **Reduction in GHG emissions from baking anodes by about 19%**
- **Elimination of SOx emission from HFO burning.**
- **Environment friendly & Cleaner Fuel.**

Benefits of ABF-1 HFO to Natural Gas Conversion







Case Study: Vedanta Ltd & BALCO - 100% Graphitization of Cathodes

- In smelting pot, Carbon is used as Anode and Cathode block for necessary electrolysis.
- Existing cathodes are of 50% graphite content which consumes more power due to less conductivity.
- These cathodes have been replaced with 100% graphitized cathodes having better conductivity and hence offer high energy savings.

Benefits of implementation:

- Resistivity reduced from **26 ohm-cm to 12 ohm-cm**.
- Operating Voltage decreased from **4.206 V to 4.110 V**
- CVD (Cathode voltage drop) decreased from **385mV to 265mV**.
- Savings: For 120 Pots -100% Graphitized Pot Installation and Normalization of Vedanta – BALCO was **82.7 Annual Mus for 2022-23**
- Investment: **1440 INR Million (16.80 Million US$)**

Conclusion and way forward

- **Incentives to reduce RE cost**
- Enhance finance availability for low-carbon technologies
- Focus on circular economy
- Enforce Environment Protection Act and **Vehicle Scrap Policy**
- Introduce quality standards and guidelines for imported scrap
- Establish domestic **carbon market**

- Engage industry players in EE and **decarbonisation target setting**
- Develop appropriate capacity building measures.
- Organize periodic cross-industry workshops

- Collaborative research like Mission Possible Partnership (MPP) and IDEEKSHA platform.
- **Joint training programs** to enhance skills related to circular economy practices.
- Development **of certifications and standards for aluminium with lower carbon footprint**.

- Implement **extended producer responsibility**.
- Lead and promote demonstration of advanced low carbon technologies.
- Encourage R&D through collaboration

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