Copper's Key Role in Cables

The use and role of copper in cables as key for efficient clean energy transition is significant. IEEMA Journal's regular column from **The International Copper Association India,** indicates the red metal's position, its movement, direction and outlook with reference to the cables industry.

As the global focus on sustainability sharpens, copper has emerged as a metal central to both economic growth and environmental stewardship. While the copper industry accounts for just 0.2% of global greenhouse gas emissions, its global demand is expected to double by 2050, driven by applications in renewable energy, electric vehicles, and digital infrastructure. This makes it essential for the industry to adopt circular practices—minimising waste, boosting recycling, and using cleaner technologies to reduce emissions.

Importantly, copper itself is a sustainable material. Producing one tonne of copper cathode represents 4.6 tonnes of CO_2 equivalent emissions. However, that same one tonne of copper:

- Can be used to manufacture 15 electric cars and abate nearly 700 tonnes of CO_2 emissions over its lifetime when charged with green power.
- Can power ~450 kW solar plant and abate 11,400 tonnes of CO_2 emissions over its lifetime
- Can power ~360 kW wind plant and abate 14,600 tonnes of CO_2 emissions over its lifetime.

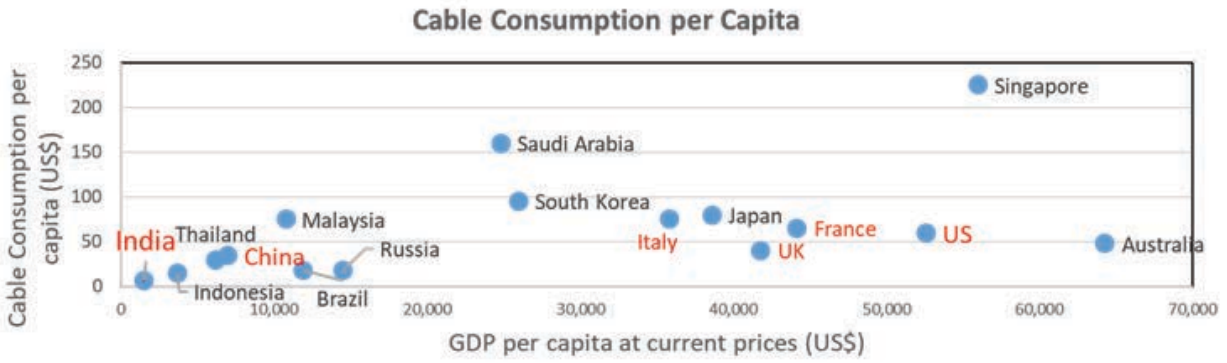
Few know that copper is infinitely recyclable without loss of performance, which makes it a key element in the circular economy. Globally, nearly two-thirds of the 690 million tonnes of copper produced over the past century are still in use today, underlining the metal's longevity.

Copper's Role in the Cables Industry

In just over a century, electricity has become the lifeblood of modern civilisation—driving industries, lighting homes, and enabling digital connectivity. As the economies around the globe have grown, the demand for reliable and efficient power distribution has also soared. At the centre of this transformation lies a critical infrastructure element: *cables.*

There is a direct correlation between a country's per capita GDP growth and per capita cable consumption growth. As the countries grow and industrialise, their demand for electricity-intensive infrastructure such as residential buildings, commercial complexes, transportation systems, and digital networks rises significantly.

As can be seen in the following chart, in the high-income countries, due to widespread electrification, urbanisation, improved urban transportation systems, and advanced manufacturing, the per capita cable consumption is higher. India, with a per capita GDP of ~$2900, is at a lower level of per

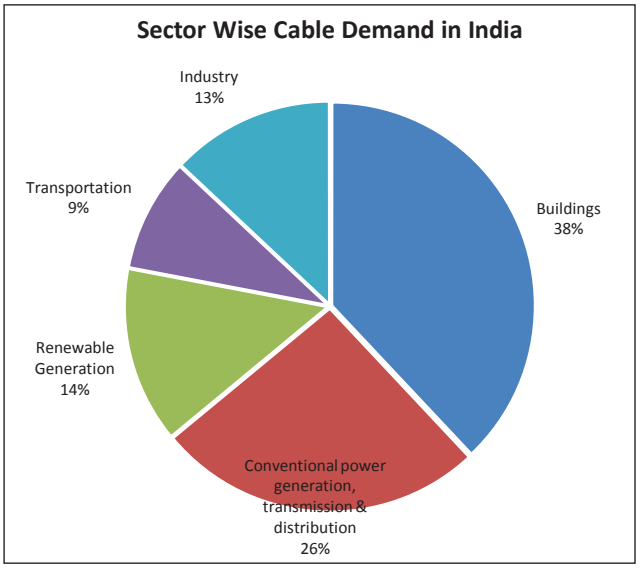


Source: International Cable Federation

capita cable consumption as compared to developed nations and several developing nations, but things are changing rapidly.

Though India is among the lower-middle-income countries, it has been one of the fastest-growing economies for more than a decade now. The growth has been fuelled by various government policy initiatives, including expanding power generation capacities with a focus on renewable energy, 24/7 affordable and quality power to all, housing for all, the Smart Cities Mission, the Gati Shakti Master Plan, the electric mobility push, railway electrification, and rapid urban mass transportation, to name a few. This also resulted in double-digit growth in key cable-consuming sectors post-pandemic.

As the Indian economy grows, the development of energy grids, rapidly growing urban cities, industrialisation, and expansion of metro and other transportation systems will lead to higher demand for cables, which are instrumental in ensuring uninterrupted, safe, and efficient power delivery.



Source: International Copper Association India

Reliability and Safety: The Backbone of Modern Infrastructure

Cables are often overlooked, but they are absolutely critical to the safety, reliability, and efficiency of our modern infrastructure—whether it's powering high-rise buildings, metro systems, or industrial plants. The selection of cables is governed by critical criteria such as:

1. **Conductor Material Selection:** Choosing metal having high conductivity and durability, ensuring minimal energy loss and longer life.
2. **Insulation and Sheathing Materials:** use of low-smoke, halogen-free, flame-retardant materials to ensure fire safety and reduce toxic emissions.
3. **Thermal and Mechanical Performance:** designing cables to withstand temperature variations, mechanical stress, and environmental exposure.
4. **Compliance with Safety Standards:** Adherence to national and international standards for electrical safety and fire resistance.
5. **Energy Efficiency and Load Optimisation:** Cable sizing and design to optimise current-carrying capacity while minimising heat loss and energy wastage.

When cables are poorly selected or installed, the consequences can be serious, leading to overheating, short circuits, and fires. For instance, power failure or fire in high-rise buildings due to a cable fault can lead to a serious challenge where evacuation is complex. In rapid mass transportation railway systems, cable failures can disrupt traction and signalling systems, compromising commuter safety and operational continuity. Industrial cable faults can halt production, damage equipment, and cause significant financial losses.

Utilities in China have shown how investing in the right cable infrastructure can help in improving the reliability of the distribution sector. China's average SAIDI hovers around ~1.5 hours/year, and SAIFI is

THE COPPER STORY

As India moves towards becoming a developed nation by 2047, the nation's copper consumption is on the rise. India's per capita copper usage stands at 1.1 kg, far below the global average of 3.3 kg, but this is changing rapidly. In FY2024 alone, copper demand in India increased 13% year-on-year to 1,700 kT. Infrastructure and construction, which account for 43% of India's copper consumption, are driving this growth.

The domestic copper production has, nevertheless, not increased in tandem with the rise in demand. Since 2018, the cathode production has already been cut in half due to the closure of Vedanta's Tuticorin smelter. This gap in refined copper production will be soon overcome through first phase of Adani's Kutch Copper smelter with 500 kT capacity per annum. However, to meet the rising demand for copper, India needs to add ~500 kT smelting and refining capacity every five years.

To address the limited domestic copper mining capacity in India, the government has introduced reforms such as the MMDR Amendment Act (2023), duty exemptions for copper concentrate, blisters & scrap and developing strategic partnership with copper-rich nations to secure long-term copper access.

India also needs to tackle quality issues associated with secondary copper usage. Thirty-eight percent (38%) of the nation's copper demand is fulfilled by secondary copper, including 468 kT of domestically generated end-of-life and process copper & alloy scrap, along with 192 kT of imported scrap in FY2024. However, a major portion of this copper undergoes direct remelting and used in the electrical and electronics segment. The direct remelting of copper raises quality concerns, especially regarding trap elements (elements that cannot be removed easily by direct remelting process) in conductor applications. ETP grade copper, with a required purity of 99.9% or more as per IS12444 standards, is crucial for all electrical installations. In India, 75% of copper demand comes from electrical applications including wires & cables, transformers, motors, and various appliances mainly due to its electrical and thermal conductivity properties.

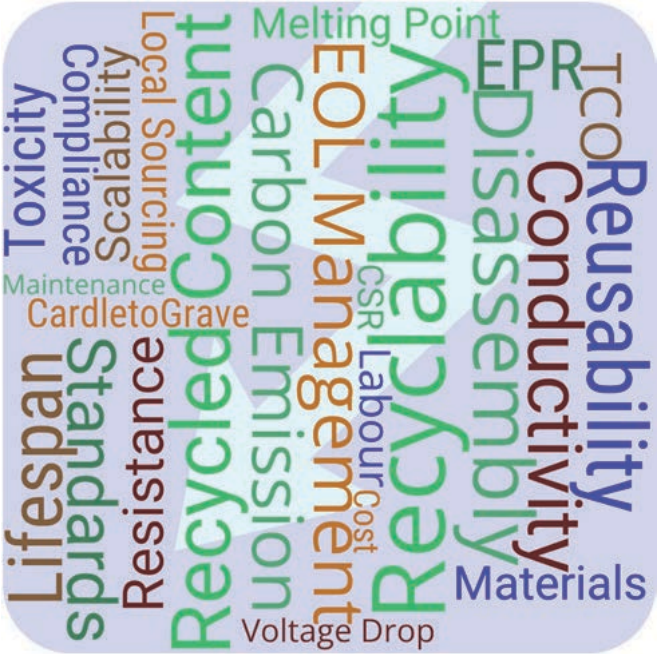
With its recyclability, role in various low carbon and emerging technologies, copper is key to India's electrical, sustainable and resilient future.

<0.5 interruptions/year (IEA, 2023), a testament to its resilient infrastructure and widespread use of copper cables. Meanwhile, Singapore—where 90% of residents live in high-rises—demonstrates cable's safety advantages, with just 0.2 electrical fires per 100,000 households annually. The city's building electrical infrastructure ensures minimal faults (0.1/km/year) and strict adherence to safety codes, keeping electrical fires below 5% of total incidents. Their success shows that smart cable choices don't just keep the lights on—they protect lives and power progress.

Sustainability and Circularity of Cables

Cables represent one of the largest uses of copper as well as aluminium conductors for electrical applications. They can have diameters ranging from 10 mm² to 4,000 mm² and have one or multiple cores. As per data provided by the Gridfinder initiative and analysis of available open data by nature.com, 7.1 million km of MV and 68.4 million km of LV grid lines are installed globally. The use of electrical conductors will increase significantly in the coming 30 years due to the energy transition and growth in power infrastructure. The cable industry not only needs to invest in a performant conductor material but also in a circular material that can be recycled and reused. The cable industry must prioritise recyclability, low-carbon materials, and lifecycle assessment (LCA) tools to minimise environmental impact.

Cable Selection Criteria



Advantage Copper

Copper cables emerge as the ideal choice for modern infrastructure due to their superior performance across key safety, efficiency, and sustainability parameters. With high conductivity (59.6 MS/m), copper ensures energy efficiency, reduced heat generation, and reliable power distribution, ensuring minimal energy loss and a longer lifecycle. Its thermal and mechanical properties allow it to withstand extreme temperatures and environmental stress.

Copper cables also support a low environmental footprint through comprehensive life cycle assessment and material end-of-life recovery that is economically attractive, achieving high recycling rates in many markets (such as over 95% in India).

Outlook

As India moves closer to its goal of becoming a $5 trillion economy and a leader in clean energy, cables will play a key role in this growth. They power everything from smart cities and electric vehicles to industrial automation and digital networks—making them essential for progress. A well-built cable infrastructure does not just ensure reliable power delivery; it also supports sustainability through recyclable materials and lower emissions.

Copper, with its high performance and recyclability, is becoming the preferred choice for conductors. This gives India a chance to build an economy that is both strong and environmentally conscious. By investing in quality, future-ready cable systems now, we can create a safer, smarter, and more sustainable future.

ABOUT THE AUTHOR

Mayur Karmarkar serves as the Market Development Leader at the International Copper Association Ltd. (ICA) and is also the Managing Director of the International Copper Association India. Under his leadership, ICA focuses on protecting and expanding copper markets while addressing critical global challenges such as electrification, urbanization, and digitalization.

With over two decades of experience in copper end-use markets across East Asia, Southeast Asia, the Middle East, and North Africa, Karmakar brings great expertise to his role overseeing institutional and programme strategies, approving new initiatives, and driving ICA's market development programmes to ensure copper's premier position.