

# PrepAlpine

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**Preparation Meets Precision**

A Next-Generation Learning Institution

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## GS Paper III: Economics

### 1. India's Next Manufacturing Leap: Why What India Produces Matters More Than How Much

#### a. Introduction

For decades, India's manufacturing debate has largely revolved around scale—producing more goods, employing more people, and expanding industrial output. While scale remains important, the global manufacturing landscape has undergone a fundamental transformation. In today's geopolitical and economic environment, the nature of what a country produces has become more critical than the sheer volume of production.

India's next manufacturing leap will therefore not be driven merely by higher quantities, but by a strategic shift towards technologically complex, high-value, and globally indispensable products. Manufacturing is no longer just an economic activity; it has become a source of resilience, strategic autonomy, and global influence.

### India's Manufacturing Shift: From Volume to Value

Old Manufacturing Paradigm	New Manufacturing Paradigm
<ul style="list-style-type: none"><li>● Focus on quantity &amp; scale</li></ul>	<ul style="list-style-type: none"><li>● Focus on product complexity &amp; value</li></ul>
<ul style="list-style-type: none"><li>● Labour-intensive, low tech</li></ul>	<ul style="list-style-type: none"><li>● Skill-intensive, technology-driven</li></ul>
<ul style="list-style-type: none"><li>● Cost competitiveness</li></ul>	<ul style="list-style-type: none"><li>● Strategic competitiveness</li></ul>
<ul style="list-style-type: none"><li>● Easy to substitute globally</li></ul>	<ul style="list-style-type: none"><li>● Globally indispensable products</li></ul>
<ul style="list-style-type: none"><li>● Vulnerable supply chains</li></ul>	<ul style="list-style-type: none"><li>● Trusted, resilient supply chains</li></ul>

### Old Manufacturing Paradigm ►► New Manufacturing

#### b. Why Global Manufacturing Strategy Is Changing

Global manufacturing today is shaped by forces that extend well beyond cost efficiency. Rising geopolitical tensions, trade wars, sanctions, and pandemic-era disruptions exposed the risks of excessive dependence on single-country supply chains. As a result, countries are actively diversifying production bases and reasserting industrial policy.

In this environment, nations that control critical technologies, trusted supply chains, and high-end manufacturing capabilities gain both economic strength and geopolitical bargaining power. Manufacturing has thus re-emerged as a strategic asset rather than a purely commercial activity.

#### c. India's Manufacturing Transition: From Volume to Value

India's manufacturing sector is gradually moving beyond low-value, labour-intensive production. Certain sectors already demonstrate India's capacity to climb the global value chain.

Electronics manufacturing has expanded rapidly, with production rising multiple times over the last decade and exports growing even faster. Similarly, India's pharmaceutical sector has established itself as a global supplier of affordable generic medicines and vaccines, accounting for a substantial share of global vaccine supply.

These sectors matter not merely because of their scale, but because they combine technological capability, value addition, and export competitiveness. They illustrate that India's manufacturing future lies in higher-value segments rather than basic assembly alone.

#### **d. Why the Next Leap Depends on What India Produces**

##### **i. Strategic Importance of Products**

Future manufacturing growth must prioritise sectors that are strategically important to the global economy. These include:

- Electronics components and semiconductors
- Pharmaceuticals and medical devices
- Green technologies and renewable energy equipment
- Advanced materials and precision engineering

Such sectors generate higher incomes, create skilled employment, reduce import dependence, and enhance India's strategic autonomy. Producing these goods embeds India more deeply into global value chains that are difficult to replace or bypass.

##### **ii. Innovation and Risk-Taking**

Advanced manufacturing requires sustained investment in research and development, experimentation with new technologies, and acceptance of uncertainty. Innovation inherently involves risk, and not all firms or technologies will succeed.

For India to move into complex manufacturing, it must develop greater tolerance for firm-level failures. An ecosystem that penalises failure discourages innovation, whereas one that allows experimentation enables technological progress and long-term competitiveness.

#### **e. Infrastructure and Logistics as the Foundation**

Manufacturing competitiveness depends critically on infrastructure and logistics. India has made notable progress in this area. Logistics costs have declined towards global benchmarks, port efficiency has improved, and initiatives such as PM Gati Shakti and the National Logistics Policy are strengthening connectivity.

Yet, structural challenges persist. Freight movement remains overly dependent on road transport, while railways and inland waterways are underutilised. Expanding multimodal transport systems can further reduce costs, improve reliability, and enhance export competitiveness.

#### **f. Industrial Clusters: Scaling Up for Global Integration**

Traditional industrial clusters in India are often small, fragmented, and low on productivity. The next phase of manufacturing growth requires a new generation of clusters that are larger, integrated, and globally connected.

These clusters should:

- Be closely linked to global value chains
- Specialise in specific products or technologies

- Be increasingly located in Tier-2 and Tier-3 cities

Such locations offer lower land and labour costs, a large workforce, and better living conditions than congested metropolitan areas. Well-planned clusters can serve as engines of regional development while anchoring India's global manufacturing presence.

### **g. MSMEs and the Manufacturing Ecosystem**

Micro, small, and medium enterprises form the backbone of Indian manufacturing, yet many operate with limited access to finance, outdated technology, and weak integration into value chains.

The next manufacturing phase provides an opportunity to integrate MSMEs as component suppliers and specialised service providers within larger industrial ecosystems. Key enablers include:

- Improved access to affordable credit
- Skill development and technology adoption
- Quality infrastructure and standardisation support

Stronger MSME participation enhances productivity, resilience, and depth across manufacturing value chains.

### **h. Regulation and Ease of Doing Business**

For manufacturing firms, ease of doing business is a practical concern rather than an abstract metric. It translates into fast approvals, predictable regulations, reliable utilities, and efficient dispute resolution.

Persistent challenges—such as land acquisition delays and regulatory uncertainty—discourage long-term investment and scaling. State and local governments play a decisive role in creating a stable, investor-friendly environment, as manufacturing policies ultimately succeed or fail at the implementation level.

### **i. Quality Standards as a Tool of Competitiveness**

Quality standards are increasingly central to global manufacturing. Instruments such as Quality Control Orders can:

- Raise domestic product standards
- Align Indian manufacturing with global norms
- Build international trust in Indian goods

However, these measures must be phased in carefully, supported by adequate testing and certification infrastructure, and designed in consultation with industry. Poorly calibrated standards risk becoming barriers rather than enablers of competitiveness.

### **j. Policy Direction: From Entry to Excellence**

India's manufacturing policy has so far focused on incentives, infrastructure creation, formalisation, and easing entry into manufacturing. These steps were essential to build initial momentum.

The next phase must emphasise:

- Technological depth and innovation
- Strong research and development ecosystems
- Close industry-academia linkages
- Creation of globally competitive firms

A coordinated framework such as a National Manufacturing Mission can integrate skills, infrastructure, innovation, and industrial policy into a coherent long-term strategy.

### Conclusion

India's next manufacturing leap will not be defined by how much it produces, but by what it produces. Technologically complex, high-value, and strategically essential goods will determine India's position in global value chains and its economic resilience.

Achieving this transition requires robust infrastructure, deeper MSME integration, credible institutions, and a willingness to embrace innovation-driven risks. Only then can manufacturing emerge as a durable engine of growth, exports, and strategic autonomy for India.

## GS Paper III: Environment

### 2. Green Steel and India's Climate Goals

#### a. Introduction

Steel is the backbone of modern economies, enabling infrastructure creation, industrial expansion, and technological progress. In India's case, steel underpins urbanisation, manufacturing growth, renewable energy deployment, and national security. From railways and housing to defence platforms and clean energy structures, steel remains a foundational input for development.

However, steel production is also among the most carbon-intensive industrial activities. As India commits itself to a long-term low-carbon development pathway, including a net-zero emissions target by 2070, the manner in which steel is produced assumes critical importance. In this context, green steel emerges as a strategic solution that aligns industrial growth with climate responsibility rather than treating them as competing objectives.



#### b. Meaning and Concept of Green Steel

### **i. Definition**

Green steel refers to steel produced using low-carbon or near-zero carbon technologies, replacing conventional coal-based processes that dominate the global steel industry today.

### **ii. Why Conventional Steel Is Carbon-Intensive**

Traditionally, steel is produced in blast furnaces that rely heavily on coking coal. Carbon emissions arise from two sources:

- Combustion of coal as a fuel to generate high temperatures
- Chemical reactions involved in reducing iron ore into molten iron

As a result, each tonne of conventional steel releases a substantial amount of carbon dioxide, making steel one of the hardest industrial sectors to decarbonise globally.

### **iii. Core Objective of Green Steel**

Green steel aims to break this structural dependence on coal by adopting cleaner energy sources and alternative production methods that sharply reduce or eliminate emissions at the source.

## **c. Importance of Steel in India's Development Trajectory**

### **i. Role in Economic Transformation**

Steel is indispensable for:

- Infrastructure development — roads, railways, bridges, ports, housing
- Manufacturing growth — machinery, automobiles, capital goods
- Strategic sectors — defence production and national security
- Clean energy transition — wind turbines, solar mounting structures

### **ii. Rising Demand and Scale Challenge**

India's development ambitions imply a sharp rise in steel demand. From a current production level of roughly 125 million tonnes, output may need to expand to over 400 million tonnes by mid-century.

This scale of expansion makes reliance on high-carbon technologies untenable. Expanding steel capacity using conventional methods would directly conflict with climate goals, making a transition to clean steel structurally unavoidable rather than optional.

## **d. Steel Sector and Climate Change Linkages**

### **i. Emissions Profile**

At present, the steel sector accounts for around 12% of India's total carbon emissions, primarily due to the dominance of coal-based blast furnace technology.

### **ii. Problem of Carbon Lock-In**

Steel plants are long-lived assets, often operating for 30–40 years. Investments made today therefore lock in emission patterns for decades.

- New coal-based capacity risks locking India into high emissions
- Retrofitting later is technologically complex and costly
- Delayed action shifts the burden to future generations

Avoiding such carbon lock-in is central to India's climate strategy.

## **e. Why Green Steel Is Crucial for India**

### **i. Meeting Climate Commitments**

Given the emission-intensive nature of steel and the long lifespan of plants, early decarbonisation is essential for achieving net-zero by 2070. Delaying the transition would require disproportionately steep emission cuts later.

### **ii. Maintaining Economic Competitiveness**

Global markets are increasingly favouring low-carbon products through:

- Carbon border taxes
- Green procurement norms
- Corporate net-zero supply chain commitments

High-carbon steel risks trade barriers and price penalties, whereas green steel enhances export resilience and long-term competitiveness.

### **iii. Strategic and Technological Leadership**

Just as India demonstrated leadership in renewable energy deployment, early adoption of green steel can position the country as a leader in sustainable industrialisation, strengthening both climate credibility and technological capability.

## **f. How Green Steel Is Produced**

### **i. Alternative Production Pathways**

Green steel relies on a combination of cleaner energy sources and alternative processes:

- Green hydrogen replacing coal as a reducing agent
- Renewable electricity powering steel plants
- Electric Arc Furnaces (EAFs) using scrap steel, drastically lowering emissions
- Carbon Capture, Utilisation and Storage (CCUS) where complete elimination is not yet feasible

### **ii. Transitional Role of Natural Gas**

Natural gas may act as a bridge fuel, offering lower emissions than coal while hydrogen production and infrastructure scale up.

## **g. India's Progress So Far**

### **i. Policy Initiatives**

India has begun laying the groundwork for green steel through:

- Development of a low-carbon steel roadmap
- Work on defining and classifying green steel
- Emission-intensity benchmarks under emerging carbon markets

### **ii. Industry Action**

Major steel producers have initiated:

- Hydrogen-based pilot projects
- Increased use of renewable electricity
- Modernisation of existing plants

While these steps signal positive intent, their scale remains insufficient relative to India's future steel demand.

## **h. Key Challenges in the Transition to Green Steel**

### **i. Economic Barriers**

Green steel plants are estimated to cost 30–50% more than conventional facilities. The high cost of green hydrogen remains the single largest constraint.

### **ii. Infrastructure Constraints**

- Limited renewable energy dedicated to industrial use
- Underdeveloped hydrogen transport networks
- Absence of carbon transport and storage infrastructure

### **iii. Resource and Equity Issues**

- Limited availability of affordable natural gas
- Fragmented and informal scrap steel market
- Small and medium producers lack capital, technology, and skilled manpower

Without targeted support, the transition risks becoming unequal and exclusionary.

## **i. Role of Government and Policy Support**

### **i. Market Creation and Pricing Signals**

- Effective carbon pricing to disincentivise polluting technologies
- Green public procurement to create assured demand
- Certification and labelling systems to build market trust

### **ii. Shared Infrastructure and Financial Support**

- Green steel clusters with access to renewable power and hydrogen
- Common carbon transport and storage facilities
- Targeted financial assistance and transition support for smaller producers

## **j. Way Forward**

India must:

- Avoid adding new high-carbon steel capacity
- Design future plants for low or near-zero emissions
- Rapidly expand renewable energy for industrial use
- Scale green hydrogen production
- Introduce predictable and credible carbon pricing

Equally important is a just transition, ensuring worker protection and support for smaller enterprises.

## **Conclusion**

Green steel lies at the intersection of India's climate commitments and its industrial aspirations. Early and decisive action can prevent long-term carbon lock-in, safeguard export competitiveness, and enable sustainable economic growth. In this sense, green steel is not merely an environmental necessity but a strategic economic choice that will shape India's development trajectory for decades to come.

## Reader's Note — About This Current Affairs Compilation

Dear Aspirant,

This document is part of the PrepAlpine Current Affairs Series — designed to bring clarity, structure, and precision to your daily UPSC learning.

While every effort has been made to balance depth with brevity, please keep the following in mind:

### 1. Orientation & Purpose

This compilation is curated primarily from the UPSC Mains perspective — with emphasis on conceptual clarity, analytical depth, and interlinkages across GS papers.

However, the PrepAlpine team is simultaneously developing a dedicated Prelims-focused Current Affairs Series, designed for:

- factual coverage
- data recall
- Prelims-style MCQs
- objective pattern analysis

This Prelims Edition will be released separately as a standalone publication.

### 2. Content Length

Some sections may feel shorter or longer depending on topic relevance and news density. To fit your personal preference, you may freely resize or summarize sections using any LLM tool (ChatGPT, Gemini, Claude, etc.) at your convenience.

### 3. Format Flexibility

The formatting combines:

- paragraphs
- lists
- tables
- visual cues

—all optimised for retention.

If you prefer a specific style (lists → paras, paras → tables, etc.), feel free to convert using any free LLM.

### 4. Monthly Current Affairs Release

The complete Monthly Current Affairs Module will be released soon, optimized to a compact 100–150 pages — comprehensive yet concise, exam-ready, and revision-efficient.

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