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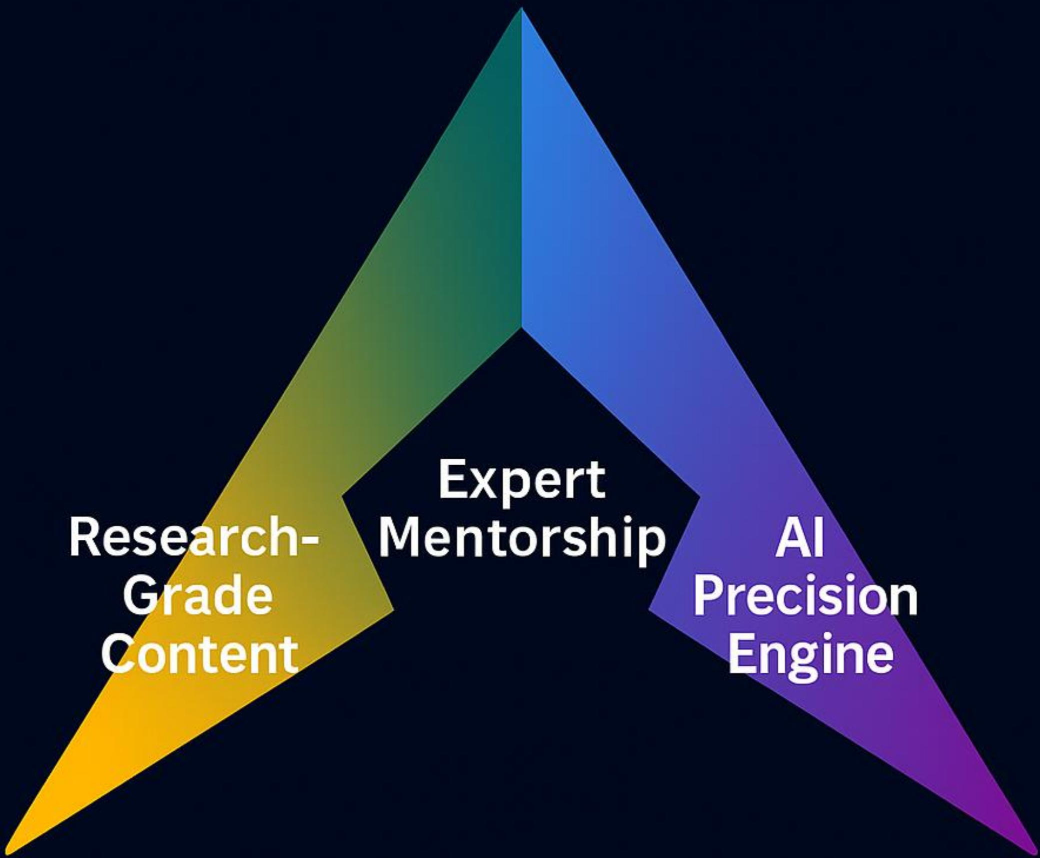
## The Next-Generation UPSC Institution

Where Research Meets Mentorship & Precision




**Preparation Meets Precision**

A Next-Generation Learning Institution

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# DAILY CURRENT AFFAIRS DATED 26.02.2026

## GS Paper II: Current Affairs

## 1. Human Papillomavirus Vaccination and Cervical Cancer Prevention

### a. Introduction: Preventing a Preventable Cancer

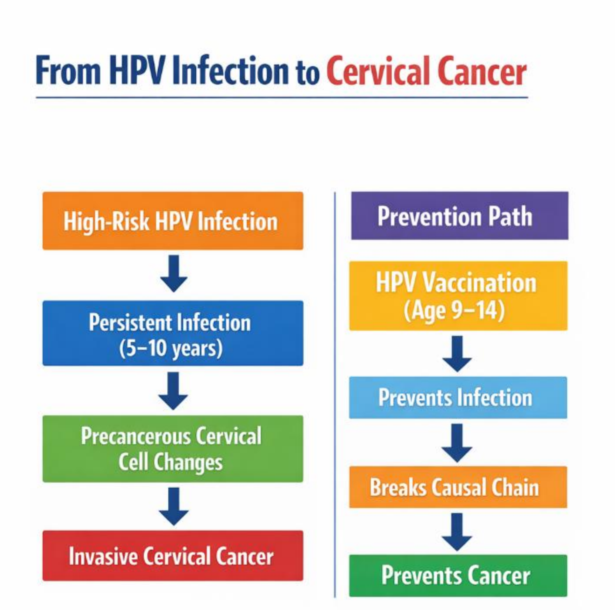
Cervical cancer remains one of the most serious public health challenges affecting women in India. Unlike many other cancers, it is largely preventable because its principal cause—persistent infection with certain types of Human Papillomavirus (HPV)—is known and preventable.

Vaccinating adolescents before exposure to the virus can break the chain of causation long before disease develops.

### b. Understanding Human Papillomavirus (HPV)

#### i. What is HPV?

Human Papillomavirus (HPV) is one of the most common sexually transmitted infections globally. More than 100 types of HPV have been identified. While many types are harmless and clear naturally, around 14 types are classified as "high-risk" because they can lead to cancer.




#### ii. Cancers Associated with High-Risk HPV

Persistent infection with high-risk HPV strains is responsible for:

- Cervical cancer (the most common HPV-related cancer)
- Anal cancer
- Penile cancer
- Vaginal and vulvar cancers
- Certain throat cancers

Nearly 90% of cervical cancer cases are linked to HPV infection. The key factor is persistence. Most infections resolve naturally, but when high-risk strains remain in the body for several years, they cause precancerous changes in cervical cells that may gradually develop into cancer.

Understanding this viral basis makes prevention through vaccination logically compelling.

### c. Cervical Cancer in India: Magnitude and Public Health Burden

India bears a disproportionately high burden of cervical cancer:

- Around 1.25 lakh new cases are reported annually.
- Nearly 75,000 women die every year due to the disease.
- India accounts for roughly one-fifth of the global cervical cancer burden.

- It is the second most common cancer among Indian women.

Although incidence has declined gradually, mortality remains high because of:

- Late detection
- Low screening coverage
- Limited awareness in rural and economically weaker sections

Many women seek medical attention only at advanced stages. Therefore, prevention through vaccination is not merely desirable but essential.

## d. How the HPV Vaccine Works

### i. Preventive (Not Curative) Nature

The HPV vaccine stimulates the immune system to recognise and fight high-risk strains before natural exposure occurs. It does not treat existing infections. Instead, it prevents future infection.

By blocking infection, the vaccine indirectly prevents the cellular changes that eventually lead to cervical cancer.

### ii. Ideal Age of Vaccination

Vaccination is recommended between 9 and 14 years of age because:

- The immune response is strongest in early adolescence, ensuring long-lasting protection.
- It is most effective when administered before the onset of sexual activity, that is, before exposure to HPV.

Thus, the strategy is forward-looking—preventing risk before it manifests.

## e. Dose Recommendations and Global Guidelines

In 2022, the World Health Organization revised its recommendations:

- For individuals aged 9–20 years: A single dose provides strong and sustained protection.
- For individuals above 21 years: Two doses are recommended, six months apart.
- Immunocompromised individuals may require three doses.

The shift to a single-dose schedule is particularly significant for countries like India because it:

- Reduces financial costs
- Simplifies logistics
- Improves coverage

This strengthens the feasibility of nationwide implementation.

## f. India's Vaccination Strategy

### i. Primary Target Group

The programme primarily targets 14-year-old girls, numbering over one crore annually. Registration and tracking are facilitated through the U-Win digital platform. Initially implemented in campaign mode, it is expected to integrate into routine immunisation over time.

### ii. Vaccine Availability

Currently, Gardasil is being used. In the future, an indigenous vaccine, Cervavac, may be deployed after receiving international approvals, including WHO prequalification. Support from GAVI has strengthened the initial rollout.

This marks a significant shift towards preventive healthcare in India's public health framework.

## g. Evidence of Effectiveness

Scientific evidence strongly supports HPV vaccination. A large study conducted in Sweden (2020) showed that women vaccinated before age 17 had an 88% lower risk of developing cervical cancer compared to unvaccinated women.

This demonstrates that vaccination does not merely reduce infection rates; it significantly reduces actual cancer incidence. In public health terms, this is a direct translation of preventive strategy into measurable health outcomes.

## h. Public Health and Developmental Significance

### i. Preventive Healthcare Orientation

India's healthcare system has historically focused more on treatment than prevention. HPV vaccination marks a structural shift toward preventive medicine, reducing long-term treatment costs and easing the burden on tertiary hospitals.

### ii. Women's Health and Gender Justice

Cervical cancer affects women during their productive years. Preventing it:

- Enhances women's participation in education and employment
- Strengthens family well-being
- Promotes gender equity

Protecting adolescent girls today ensures long-term socio-economic stability.

### iii. Human Capital and Demographic Dividend

Healthy adolescents form the foundation of a strong workforce. Reduced premature mortality and lower chronic illness improve productivity and reinforce India's demographic dividend.

### iv. Herd Immunity

When a large proportion of adolescent girls are vaccinated, overall viral transmission declines. Even unvaccinated individuals benefit indirectly, creating community-level protection.

## i. Implementation Challenges

Despite its promise, several challenges remain:

- Vaccine hesitancy due to misconceptions regarding fertility or sexual behaviour
- Cultural sensitivity surrounding discussion of sexually transmitted infections
- Low awareness in rural and marginalised communities
- Logistical challenges such as cold-chain maintenance and reaching out-of-school girls
- Timely regulatory approvals for indigenous vaccines

Addressing these concerns is critical for universal coverage.

## j. International Perspective

Countries such as Australia and the United Kingdom have implemented school-based universal HPV vaccination programmes with remarkable success. Australia is projected to virtually eliminate cervical cancer as a public health problem.

The World Health Organization has set a target of vaccinating 90% of girls by age 15 by 2030. India's initiatives align with this global elimination strategy.

### k. Way Forward

To maximise impact:

- Fully integrate HPV vaccination into the Universal Immunisation Programme
- Strengthen school-based delivery mechanisms
- Conduct sustained awareness campaigns to dispel myths
- Fast-track regulatory approvals for indigenous vaccines
- Consider gradual inclusion of boys to strengthen herd immunity

A comprehensive approach combining vaccination, screening, and awareness can move India toward elimination.

### Conclusion

Cervical cancer is largely preventable, and HPV vaccination offers a scientifically proven and cost-effective solution. By investing in adolescent immunisation, India invests in the health, dignity, and productivity of future generations.

If implemented equitably and effectively, widespread HPV vaccination can transform women's health outcomes and bring the country closer to eliminating cervical cancer as a public health threat in the coming decades.

## GS Paper III: Science and Technology

## 2. Training Large Language Models in India: Challenges, Policy Support and Mixture of Experts Architecture

### a. Introduction: Artificial Intelligence as a Strategic Technology

Artificial Intelligence (AI) systems such as chatbots and generative tools are powered by Large Language Models (LLMs). A Large Language Model is a deep learning system trained on massive volumes of text so that it can understand and generate human-like language.

Today, LLMs influence:

- Economic competitiveness
- National security
- Governance efficiency
- Technological leadership

As AI becomes a strategic technology, countries are developing indigenous LLMs to ensure digital sovereignty, cultural alignment, and economic advantage. For India, building such models domestically presents both opportunity and structural challenges.

### b. How Large Language Models Are Trained

#### i. The Role of Compute Power

Compute refers to the computational power required to train AI systems.

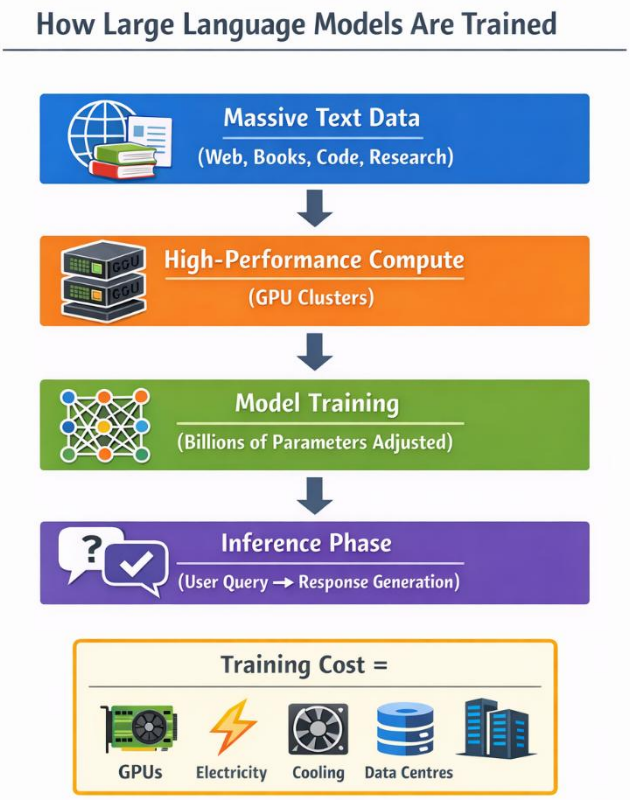
LLMs are trained using Graphics Processing Units (GPUs). GPUs are specialised chips designed to perform thousands of calculations simultaneously — parallel processing. This makes them suitable for training deep neural networks.

In contrast, Central Processing Units (CPUs) handle tasks sequentially and are less efficient for large-scale AI training.

Training a frontier LLM typically involves:

- Thousands of GPUs working together in clusters
- Several weeks or months of continuous computation
- High expenditure on chips, data centres, cooling, and electricity

The total cost can run into hundreds or even thousands of crores of rupees. Therefore, compute becomes a major entry barrier.




**ii. Data as the Core Input**

LLMs learn patterns from text data. The better and more diverse the data, the better the model performs.

Common data sources include:

- Websites
- Books
- Research articles
- Code repositories

However, global digital content is heavily skewed toward English and a few major languages. Indian languages are underrepresented online. This imbalance affects model performance in regional contexts.

Thus, data availability is as important as computational power.

## c. Why Training Large Language Models in India Is Challenging

### i. Limited High-Quality Indian Language Data

Many Indian languages lack structured and digitised corpora — large, organised text collections. While spoken usage is abundant, curated digital datasets are limited.

As a result:

- Models may perform poorly in regional languages.
- They may internally translate into English, increasing computational cost.
- Cultural nuances may be lost.

**ii. High Capital Costs**

Training advanced LLMs requires:

- Expensive imported GPUs
- Large-scale electricity consumption
- Substantial financial backing

In countries like the United States and China, technology firms are supported by deep venture capital ecosystems. Indian startups often operate with tighter funding constraints.

**iii. Infrastructure Gaps**

India:

- Has limited domestic semiconductor manufacturing capacity.
- Depends heavily on imported AI chips.
- Is expanding data centres but still trails global leaders in hyperscale infrastructure.

**iv. Competitive Pressure**

Frontier global models have hundreds of billions or even trillions of parameters.

A parameter is a numerical value in a neural network that adjusts during training to improve accuracy. Generally, larger models require more compute but may achieve broader capabilities.

Indian firms must balance:

- Efficiency
- Cost
- Accuracy
- Multilingual performance

without necessarily competing directly in model size.

Given these constraints, policy support becomes essential.

### d. IndiaAI Mission: A Policy Intervention

Recognising structural challenges, the Government of India launched the IndiaAI Mission.

**i. Common Compute Facility**

A major initiative is the establishment of a common compute facility with over 36,000 GPUs in Indian data centres.

Key features:

- Operated by domestic firms
- Accessible to startups and research institutions
- Available at subsidised rates

This reduces entry barriers and dependence on foreign cloud providers.

Startups like Sarvam AI and academic initiatives such as BharatGen have utilised such infrastructure for domestic model training.

**ii. Broader Objectives**

The mission aims to:

- Promote domestic AI development
- Strengthen digital sovereignty

- Foster talent and research
- Build AI systems aligned with Indian linguistic and governance needs

Policy intervention thus attempts to correct market and infrastructure gaps.

### e. Indian Efforts in Large Language Model Development

Several Indian organisations are developing indigenous models.

**Sarvam AI**

- Models with tens of billions of parameters
- Focus on efficiency and multilingual capability

**BharatGen**

- Led by academic institutions
- Multilingual models for healthcare and education

**Gnani.ai**

- Speech-based systems
- Focused on Indian languages

Though smaller than global frontier systems, these models are optimised for Indian use cases and cost efficiency.

To further improve efficiency, architectural innovations are being explored.

### f. Understanding Mixture of Experts (MoE) Architecture

#### i. Traditional Model Design

In earlier LLMs:

- Every query activates all parameters.
- Even simple questions require full model computation.
- Larger models mean higher inference cost — cost of generating responses.

This increases energy use and operational expenses.

#### ii. Concept of Mixture of Experts

The Mixture of Experts (MoE) architecture improves efficiency.

In this approach:

- The model is divided into multiple specialised sub-networks called "experts."
- A routing mechanism selects only relevant experts for a given query.
- Only a subset of the model is activated.

This leads to:

- Lower computational load
- Reduced energy consumption
- Faster response times
- Better scalability

For countries with limited capital resources, such efficiency-driven design is strategically advantageous.

MoE allows India to compete through smart architecture rather than sheer model size.

## g. Strategic Importance of Indigenous LLMs

### i. Digital Sovereignty

Dependence on foreign AI systems raises concerns regarding:

- Data privacy
- Cultural representation
- Strategic vulnerability

Indigenous models allow greater control and alignment with local contexts.

### ii. Economic Transformation

AI is a general-purpose technology—a technology with wide applications across sectors — similar to electricity or the internet.

Domestic LLMs can:

- Improve productivity
- Stimulate innovation ecosystems
- Create new employment opportunities

### iii. Governance and Public Services

Multilingual AI systems can:

- Power citizen service portals
- Automate document analysis
- Assist in education delivery
- Improve healthcare communication

In a linguistically diverse country like India, locally trained models enhance inclusion.

## h. Risks and Limitations

Despite promise, challenges remain:

- Excessive subsidisation may reduce innovation incentives.
- Continued chip imports limit technological autonomy.
- Ethical concerns such as algorithmic bias and misinformation persist.
- Matching global frontier scale remains difficult.

Therefore, scale must be balanced with responsibility.

## i. Way Forward

India's long-term strategy should focus on:

**Building High-Quality Indian Language Datasets**

- Large, open corpora
- Public-private data partnerships

**Strengthening Semiconductor Ecosystem**

- Domestic chip manufacturing

- Strategic technology partnerships

**Promoting Open-Source Research**

- Democratise innovation
- Avoid duplication

**Focusing on Efficiency and Relevance**

Rather than competing in sheer parameter size, emphasis should be on:

- Multilingual capability
- Cost efficiency
- Contextual relevance

Architectures like Mixture of Experts can play a crucial role.

### Conclusion

Training Large Language Models in India is not merely a technological ambition but a strategic necessity. High capital costs, infrastructure limitations, and data constraints pose serious challenges.

However, policy initiatives such as the IndiaAI Mission and architectural innovations like Mixture of Experts provide viable pathways forward.

India's comparative advantage may lie not in building the largest models globally, but in developing efficient, multilingual, and socially aligned AI systems that address national priorities and developmental needs.

## GS Paper III: Environment

## 3. Carbon Capture and Utilisation: Concept, Global Models and India's Roadmap

### a. Introduction: Climate Responsibility and Industrial Reality

Climate change mitigation requires a dual approach. First, countries must reduce future greenhouse gas emissions through renewable energy and efficiency improvements. Second, they must manage emissions from industries where carbon dioxide ($CO_2$) is an unavoidable by-product of production.

It is in this context that Carbon Capture and Utilisation (CCU) has emerged as an important technological intervention. For India, which seeks to balance economic growth with climate responsibility, CCU connects environmental protection with industrial policy, technological innovation, and sustainable development.

### b. Understanding Carbon Capture and Utilisation

#### i. What is CCU?

Carbon Capture and Utilisation (CCU) refers to technologies that:

- Capture carbon dioxide from industrial sources or directly from the atmosphere.
- Convert the captured carbon dioxide into useful products instead of releasing it into the air.

In simple terms, CCU treats carbon dioxide not as waste, but as a resource.

#### ii. How the Process Works

The process involves two main stages:

**Carbon Capture**

$CO_2$ is captured from:

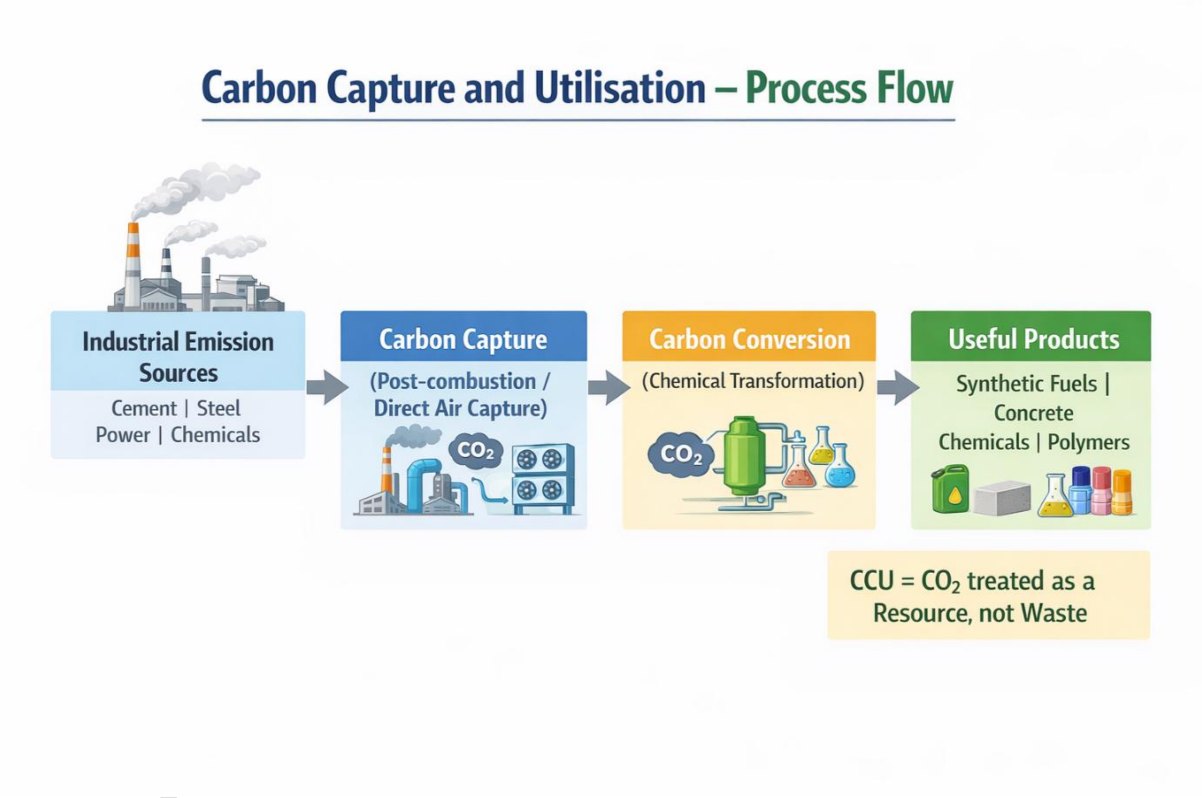
- Cement plants
- Steel factories
- Thermal power stations
- Chemical industries
- Direct Air Capture — removal from ambient air

**Carbon Conversion**

The captured $CO_2$ is chemically transformed into valuable outputs such as:

- Synthetic fuels
- Construction materials
- Industrial chemicals
- Polymers and plastics

Thus, instead of allowing emissions to accumulate in the atmosphere, carbon is redirected into productive economic use.




## c. CCU vs Carbon Capture and Storage (CCS)

It is important to distinguish CCU from Carbon Capture and Storage (CCS).

### i. Carbon Capture and Storage (CCS)

- $CO_2$ is captured.
- It is permanently stored underground in geological formations.
- Objective: Long-term isolation from the atmosphere.

### ii. Carbon Capture and Utilisation (CCU)

- $CO_2$ is captured.

- It is reused in economic activities.
- Objective: Productive recycling within the economy.

While CCS focuses on containment, CCU focuses on productive reuse. CCU aligns closely with the idea of a circular carbon economy, where carbon is recycled rather than discarded.

Understanding this distinction clarifies why CCU is seen as both an environmental and industrial strategy.

## d. Why Carbon Capture and Utilisation is Important

### i. Addressing Hard-to-Abate Sectors

Some industries are described as "hard-to-abate" sectors. These are sectors where emissions cannot be eliminated simply by switching to renewable electricity.

**Cement Industry**

When limestone is processed to make cement, $CO_2$ is released as part of a chemical reaction. Even if renewable energy is used, this process-based emission continues.

**Steel and Chemical Industries**

These industries involve chemical reactions that inherently generate $CO_2$.

In such sectors, CCU provides a complementary solution by capturing emissions at the source.

### ii. India's Emissions Context

India is the third-largest emitter of carbon dioxide globally. Major contributors include:

- Coal-based power generation
- Cement manufacturing
- Steel production

At the same time, India has committed to achieving net-zero emissions by 2070.

Given India's developmental needs, CCU can serve as a transitional or bridge technology, enabling economic growth while reducing emissions intensity.

## e. Mechanism of Emission Reduction

CCU contributes to emission reduction in two main ways.

**Preventing Atmospheric Release**

By capturing $CO_2$ before it enters the atmosphere, industrial emissions are directly reduced.

**Substituting Fossil-Based Inputs**

When captured $CO_2$ is used to produce fuels or chemicals:

- It reduces dependence on newly extracted fossil fuels.
- The same carbon atom is reused within the economic system.

This strengthens its role in sustainable industrial transformation.

## f. Applications of Carbon Capture and Utilisation

Technological innovation has expanded CCU applications.

### i. Synthetic Fuels

Captured $CO_2$ can be converted into:

- Methanol
- Ethanol
- Synthetic aviation fuels

**ii. Construction Materials**

$CO_2$ can be injected into concrete, which:

- Improves strength
- Permanently embeds carbon in buildings

**iii. Industrial Chemicals and Plastics**

$CO_2$ can serve as a feedstock for polymers and chemicals.

These applications create new green value chains and open avenues for industrial diversification.

As global examples show, supportive policies play a crucial role in scaling these technologies.

## g. Global Policy Experience

**i. European Union**

The EU integrates CCU within:

- Bioeconomy Strategy
- Circular Economy Action Plan

These frameworks promote sustainable resource use and recognise $CO_2$ as a potential industrial resource.

**ii. United States**

The US provides financial incentives such as:

- 45Q tax credits

These reduce project costs and enhance commercial viability.

**iii. United Arab Emirates**

Projects such as Al Reyadah demonstrate:

- Integration of carbon capture with hydrogen production
- Industrial cluster-based utilisation

This "industrial ecosystem" model improves economic feasibility.

Global experiences highlight the importance of policy incentives and cluster-based development.

## h. India's Current Status

India is at an early but promising stage of CCU development.

**i. Government Initiatives**

- Department of Science and Technology has prepared a CCUS research roadmap.
- A draft roadmap for 2030 identifies pilot and demonstration projects.

**ii. Private Sector Efforts**

- Ambuja Cements is experimenting with CCU in cement plants.

- JK Cement is testing $CO_2$-based concrete blocks.
- Organic Recycling Systems is converting $CO_2$ from biogas into bio-alcohols.

However, most initiatives remain at pilot scale. Large-scale commercial deployment has not yet occurred.

Scaling up requires addressing key structural challenges.

## i. Key Challenges in Scaling CCU in India

### i. High Cost and Energy Intensity

CCU technologies require:

- Advanced equipment
- High energy input

$CO_2$-derived products are often more expensive than conventional alternatives.

### ii. Infrastructure Limitations

Effective deployment requires:

- Capture units
- Transport pipelines
- Industrial clusters for utilisation

India currently lacks extensive carbon transport infrastructure.

### iii. Policy and Regulatory Gaps

- Absence of comprehensive carbon pricing
- Limited demand-side incentives
- Evolving standards for measurement and verification

### iv. Environmental Integrity

If $CO_2$-derived fuels are later burned, carbon may re-enter the atmosphere. Therefore, life-cycle assessment is essential to ensure genuine net emission reductions.

Addressing these challenges is critical for moving from pilots to scale.

## j. Roadmap for India

To unlock CCU's potential, India must adopt a strategic and phased approach.

### i. Policy Incentives

- Carbon pricing mechanisms
- Tax credits
- Viability gap funding

### ii. Industrial Clusters

Develop CCU hubs in:

- Cement belts
- Steel corridors
- Petrochemical zones

Cluster-based development reduces cost through economies of scale.

**iii. Integration with Green Hydrogen**

Renewable hydrogen combined with captured $CO_2$ can produce:

- Synthetic fuels
- Low-carbon chemicals

This creates synergy between two emerging green sectors.

**iv. Regulatory Framework**

A robust system for:

- Measurement
- Reporting
- Verification

is essential for investor confidence and environmental credibility.

## Conclusion

Carbon Capture and Utilisation represents a pragmatic bridge in the climate transition. For India, it offers an opportunity to decarbonise hard-to-abate sectors while fostering green industrial innovation.

Yet technological promise alone is insufficient. High costs, infrastructure gaps, and policy uncertainties must be addressed through coordinated planning and targeted incentives.

If aligned with circular economy principles and integrated into India's broader climate strategy, CCU can become a significant pillar of India's pathway towards net-zero emissions by 2070.

# 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.