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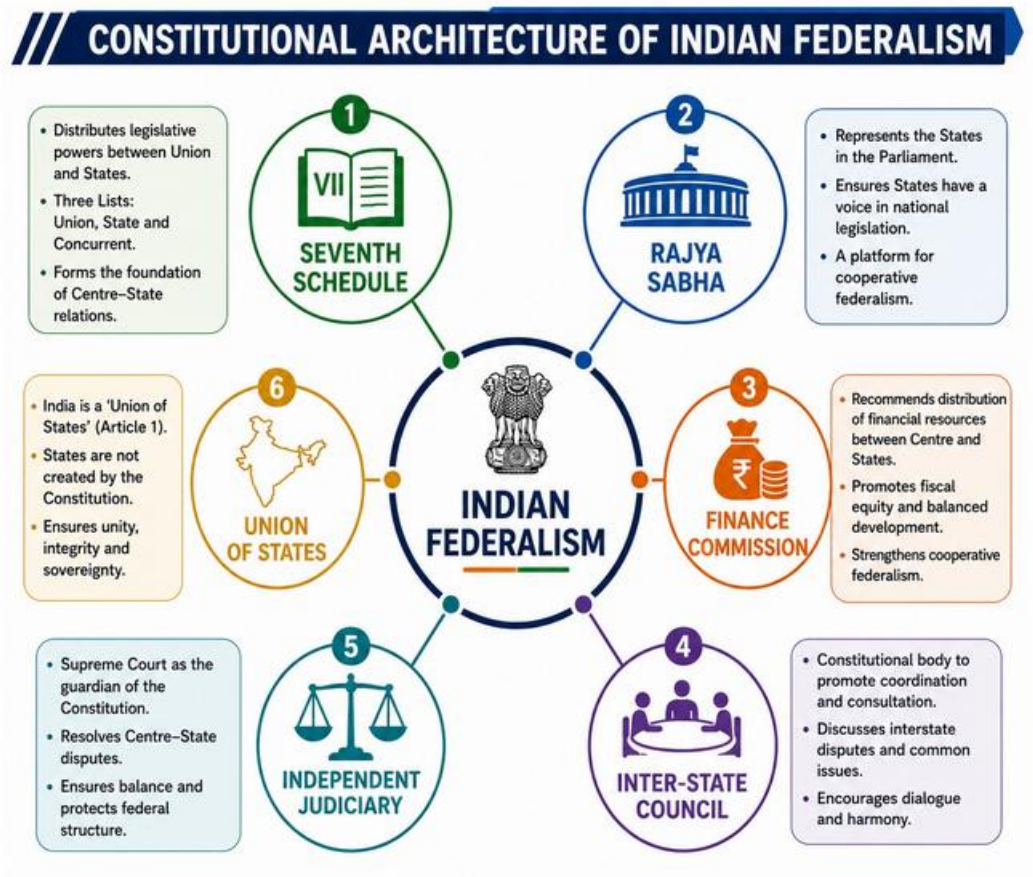
DAILY CURRENT AFFAIRS DATED 19.05.2026

GS Paper II: Polity

1. Federalism Challenges in India: Consensus as the Solution

a. Introduction

The debate surrounding India's federal structure has gained renewed prominence amid discussions on post-2026 delimitation, disputes over fiscal transfers, concerns regarding centralisation of power, and growing tensions in Centre–State relations. Political scientists such as Devesh Kapur and economist Arvind Subramanian argue that the long-term stability of Indian federalism depends not merely on constitutional arrangements, but on democratic consultation, political accommodation, and consensus-building among stakeholders.



b. Understanding Indian Federalism

India's Constitution establishes a unique federal system with a strong unitary bias. Article 1 describes India as a “Union of States,” reflecting the objective of preserving national unity while accommodating regional diversity.

Key Features of Indian Federalism

- Division of legislative powers between the Union and the States through the Seventh Schedule.
- A bicameral Parliament, with the Rajya Sabha representing the interests of the States.
- An independent judiciary acting as the guardian of the Constitution.
- The Finance Commission under Article 280 for fiscal devolution.
- The Inter-State Council under Article 263 to facilitate Centre–State coordination.

Indian federalism has historically relied not only on constitutional provisions but also on political accommodation, mutual trust, and cooperative governance.

c. Why is Indian Federalism Under Strain?

Emerging Sources of Stress

- The current debate arises from a combination of political, economic, and demographic changes that have generated new challenges for the federal framework.

Major Areas of Concern

Issue	Nature of Concern
Democratic Representation	Imbalances arising from frozen parliamentary seat allocation
Fiscal Federalism	Disputes over redistribution of tax revenues
Regional Divergence	Growing developmental gaps among states
Political Centralisation	Perceived weakening of state autonomy
Trust Deficit	Erosion of cooperative Centre–State relations

These challenges have revived questions regarding how India can maintain national unity while ensuring fairness among its diverse regions.

d. Proximate Challenge I: The Growing Democratic Deficit

Delimitation and Representation

One of the most significant challenges concerns parliamentary representation.

The 42nd Constitutional Amendment Act, 1976 froze the allocation of Lok Sabha seats among states based on the 1971 Census. This freeze was subsequently extended by the 84th Constitutional Amendment Act, 2001, until the first Census conducted after 2026.

The original rationale was to ensure that states implementing effective population-control measures would not be politically disadvantaged.

However, demographic trends have diverged sharply over the past five decades.

States with Lower Fertility Rates

- Tamil Nadu
- Kerala
- Andhra Pradesh
- Telangana
- West Bengal

States with Higher Fertility Rates

- Uttar Pradesh
- Bihar
- Madhya Pradesh
- Rajasthan

As a result, several southern states currently enjoy a larger share of parliamentary representation relative to their present population, while some northern states remain under-represented.

The Fundamental Dilemma

The impending delimitation exercise raises a difficult constitutional question:

Should democratic representation be determined strictly by population, or should states that successfully implemented population stabilisation policies be protected from political disadvantage?

Balancing democratic equality with federal fairness will be one of the most sensitive political challenges in the coming years.

e. Proximate Challenge II: Rising Fiscal Tensions

Understanding Fiscal Federalism

- Fiscal federalism refers to the allocation of financial resources and expenditure responsibilities between the Union and the States.

Role of the Finance Commission

- Recommending tax devolution.
- Suggesting grants-in-aid.
- Designing mechanisms for intergovernmental resource sharing.

Emerging Concerns

- Over time, economically stronger states have contributed a disproportionately large share of national tax revenues, while poorer states have received a larger share through redistributive transfers.

Major Contributor States

- Maharashtra
- Gujarat
- Haryana
- Several southern states

Major Recipient States

- Uttar Pradesh
- Bihar
- Madhya Pradesh
- Odisha
- West Bengal

Redistribution remains essential for promoting balanced regional development. However, when transfers are perceived as excessive or permanent, contributor states may develop grievances regarding fairness and incentives.

Core Fiscal Dilemma

- Ensuring equity through redistribution.
- Preserving incentives for economic performance.
- Maintaining political legitimacy of transfers.

The resulting tensions create a delicate balance between equity and efficiency within the federal system.

f. Deeper Structural Cause I: Divergent Development Trajectories

Uneven Economic Transformation

- Many federal tensions stem from widening developmental differences among states.

High-Performing Regions

Since economic liberalisation, states in southern and western India, along with Haryana, have generally achieved:

- Higher per capita incomes.
- Better human development indicators.
- Greater industrialisation.
- Stronger governance outcomes.

Lagging Regions

Several states, particularly in northern and eastern India, continue to face challenges relating to:

- Poverty reduction.
- Human capital development.
- Industrial growth.
- Employment generation.

Implications for Federalism

A successful federation must reconcile three competing objectives:

- Democratic representation.
- Economic efficiency.
- Regional equity.

Federal tensions become more pronounced when better-performing states perceive that they are being penalised for success, while poorer states are viewed as benefiting disproportionately from redistribution.

g. Deeper Structural Cause II: Erosion of Democratic Sensibility

From Cooperative to Combative Federalism

The more serious challenge lies not in institutional design but in changing political behaviour.

Several major policy initiatives have generated criticism from states on the grounds of inadequate consultation, including:

- Demonetisation.
- The farm laws.
- The Citizenship Amendment Act, 2019.
- Criminal law reforms.
- Electoral reforms.
- Certain constitutional amendment proposals.

Whether these criticisms are fully justified or not, the perception of unilateral decision-making has contributed to growing mistrust between the Centre and the States.

Consequences

- Weakening of intergovernmental trust.
- Erosion of institutional legitimacy.
- Decline of cooperative federalism.
- Reduced national cohesion.

h. Democratic Sensibility: The Missing Ingredient

Lessons from the GST Council

During discussions regarding taxation of gambling activities, Kerala's Finance Minister, T. M. Thomas Isaac, found himself isolated in opposition to the prevailing view.

Despite possessing the numerical strength to proceed through voting, then Union Finance Minister Arun Jaitley sought consensus and attempted to accommodate dissenting concerns.

The Larger Lesson

Federal institutions function effectively when:

- Majorities exercise restraint.
- Minority concerns receive respect.
- Consensus is preferred over coercion.
- Dialogue precedes decision-making.

This spirit of accommodation is often more important than constitutional provisions themselves.

i. Why Cooperative Federalism Matters

- **National Integration:** Federalism enables the peaceful accommodation of India's linguistic, cultural, ethnic, and regional diversity.
- **Better Governance:** States serve as laboratories of innovation, experimenting with policies that can later be adopted nationally.
- **Balanced Regional Development:** Fiscal transfers help reduce disparities and promote inclusive growth across regions.
- **Democratic Deepening:** Decentralised governance increases accountability, participation, and responsiveness.
- **Conflict Management:** Federal arrangements provide institutional mechanisms for resolving political and regional tensions peacefully.

j. Major Challenges Before Indian Federalism

Challenge	Impact
Delimitation after 2026	Potential North–South political tensions
Fiscal redistribution disputes	Contributor versus beneficiary conflicts
Governor-related controversies	Centre–State distrust
Centralisation of policymaking	Reduced state autonomy
Regional developmental divergence	Persistent inequality
Political polarisation	Weakening consensus-based governance

k. Recommendations of Important Commissions

Sarkaria Commission (1988)

- Greater consultation between the Centre and the States.
- Restrained use of Article 356.
- Strengthening of the Inter-State Council.
- Respect for the federal spirit of the Constitution.

Punchhi Commission (2010)

- Clearer demarcation of Centre–State responsibilities.
- Improved mechanisms for dispute resolution.
- Stronger cooperative federal institutions.
- Greater autonomy for states in appropriate domains.

l. GST Council: A Model of Cooperative Federalism

Why It is Considered Successful

The GST Council is often regarded as one of the most successful examples of cooperative federalism in contemporary India.

Key Features

- Continuous dialogue.
- Institutionalised consultation.
- Consensus-oriented decision-making.
- Shared ownership of outcomes.

The Council demonstrates that federal cooperation can be achieved when political actors prioritise negotiation over confrontation.

m. Critical Analysis

The Core Argument

India's federal challenges are fundamentally political rather than constitutional.

Real Sources of Tension

- Increasing developmental divergence among states.
- Weakening traditions of consultation and accommodation.

Why Constitutional Engineering Alone is Insufficient

No constitutional formula can permanently resolve disputes concerning:

- Representation.
- Resource allocation.
- Regional identity.
- Political power.

These issues can only be managed through a democratic culture that values dialogue, compromise, and mutual respect.

Key Insight

The survival of Indian federalism ultimately depends less on constitutional engineering and more on the willingness of political actors to exercise restraint, build trust, and seek consensus.

n. Way Forward

- **Strengthening Federal Institutions:** The Inter-State Council should be revitalised as a regular forum for dialogue and conflict resolution. Similarly, the GST Council's consensus-based approach can be extended to other areas of intergovernmental cooperation.
- **Building Consensus on Delimitation:** Any post-2026 delimitation exercise must emerge from broad national consultation. States that successfully controlled population growth should not perceive themselves as being penalised.
- **Reforming Fiscal Federalism:** Fiscal transfers should balance equity with incentives for good governance, development performance, and fiscal responsibility.
- **Enhancing Political Consultation:** Major policies affecting states should be preceded by structured consultations to reduce mistrust and strengthen cooperative governance.
- **Reviving Constitutional Morality:** Federalism flourishes when constitutional powers are exercised with restraint, respect for dissent, and sensitivity towards regional aspirations.

Conclusion

Indian federalism has endured because it combines constitutional flexibility with political pragmatism. As debates over delimitation, fiscal redistribution, and regional representation intensify, the sustainability of the federal system will depend not merely on institutional structures but on a renewed commitment to consultation, accommodation, and cooperative governance. In a diverse democracy such as India, consensus-building remains the most durable foundation of unity, stability, and national integration.

GS Paper II: International Relations

2. India–Sweden and India–Norway Green Partnerships: Advancing Sustainable Growth and Strategic Cooperation

a. Introduction

Prime Minister Narendra Modi visited Sweden and Norway during his European tour, leading to significant advancements in India's green diplomacy and sustainable development partnerships.

India and Sweden reaffirmed their commitment to green industrial transformation through the Leadership Group for Industry Transition (LeadIT), while India and Norway elevated bilateral ties to a Green Strategic Partnership. The visits also resulted in agreements covering clean energy, digital development, health cooperation, Arctic research, maritime affairs, and space technology.

These developments highlight India's increasing engagement with developed economies to accelerate sustainable growth, climate action, technological innovation, and global governance reforms.

b. Background: India's Climate and Development Vision

i. Balancing Growth and Sustainability

India's development strategy seeks to balance economic growth with environmental sustainability.

Major National Goals

Goal	Target
Viksit Bharat	2047
Net Zero Emissions	2070

Expansion of Non-Fossil Fuel Capacity	Ongoing
Green Industrial Transformation	Long-term

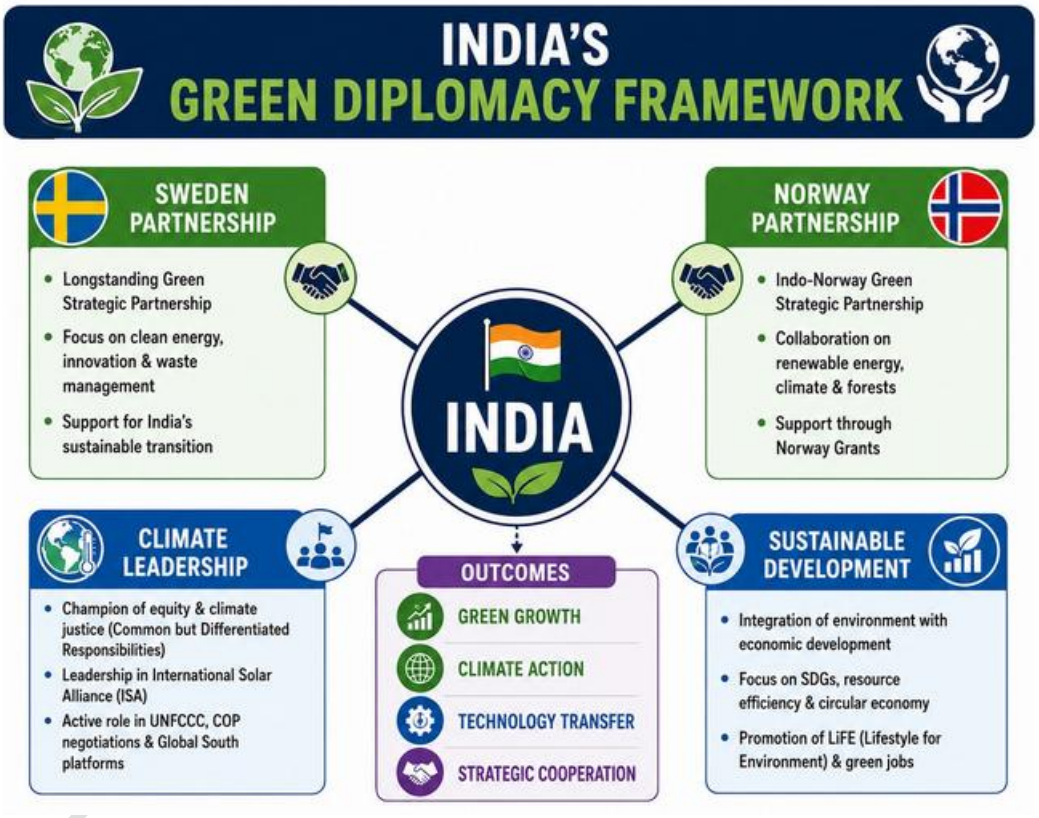
India consistently maintains that climate action and economic development should not be viewed as competing objectives. Instead, sustainable growth can become a catalyst for long-term prosperity.

ii. Principle of CBDR-RC

India's position is rooted in the principle of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC) under the United Nations Framework Convention on Climate Change.

Core Elements

- Recognition of differing historical emissions responsibilities.
- Consideration of varying developmental capacities.
- Equitable burden-sharing in climate action.
- Protection of developmental space for developing countries.



c. India–Sweden Partnership: Driving Green Industrial Transformation

Key Areas of Cooperation

The India–Sweden partnership has become a significant pillar of India's climate and industrial strategy.

Areas of Collaboration

- Sustainable industrial development.
- Industrial decarbonisation.
- Green technology deployment.
- Climate-resilient economic growth.

- Sustainable supply chains.

The partnership reflects a shared understanding that future competitiveness will increasingly depend upon low-carbon industrial systems.

d. Leadership Group for Industry Transition (LeadIT)

Background

LeadIT was jointly launched by India and Sweden in 2019 with support from the United Nations.

Its objective is to accelerate the transition of carbon-intensive industries towards sustainable and low-emission production systems.

Key Objectives

- Decarbonisation of hard-to-abate sectors.
- Promotion of green manufacturing.
- Expansion of sustainable finance.
- Development of clean-energy supply chains.
- Facilitation of technology partnerships.

Emerging Areas of Cooperation

Area	Focus
Technology Transfer	Green industrial technologies
Sustainable Finance	Lowering climate investment costs
Workforce Transition	Green skills and employment
Supply Chains	Resilient clean-energy ecosystems
Industrial Demonstration Projects	Large-scale decarbonisation initiatives

For India, LeadIT provides an important platform to access technology, investment, and best practices required for industrial transformation.

e. Why Sweden Matters for India's Green Transition

i. Sweden as a Sustainability Model

Sweden is widely recognised as one of the world's most successful examples of sustainable development.

Sweden's Climate Performance

Indicator	Achievement
Electricity Generation	Approximately 98% fossil-free
Emission Reduction	More than one-third decline since 1990

Economic Growth	Economy nearly doubled during the same period
Innovation Capacity	Global leader in clean technologies

The Swedish experience demonstrates that economic growth and emissions reduction can proceed simultaneously when supported by innovation, technological advancement, and effective public policy.

ii. Lessons for India

- Green industrialisation.
- Circular economy practices.
- Clean energy technologies.
- Sustainable urban development.
- Resource efficiency.

f. India–Norway Green Strategic Partnership

Elevation of Bilateral Relations

India and Norway have elevated their bilateral relationship to a Green Strategic Partnership, signalling a broader and more comprehensive framework of cooperation.

The partnership extends beyond climate issues to encompass technology, maritime affairs, health, space research, digital governance, and sustainable development.

Core Areas of Cooperation

- Green energy.
- Climate resilience.
- Blue Economy.
- Green shipping.
- Digital development.
- Space technology.
- Arctic research.

The partnership reflects growing convergence between India's developmental priorities and Norway's expertise in sustainable technologies and ocean-based industries.

g. Major Agreements Under the Partnership

i. Space Cooperation

An agreement was concluded between Indian Space Research Organisation and the Norwegian Space Agency.

Significance

- Strengthening Earth observation capabilities.
- Improving climate monitoring systems.
- Advancing scientific research.
- Supporting space-based applications for sustainable development.

Enhanced space collaboration will improve environmental monitoring and support evidence-based policymaking.

ii. Health Cooperation

The two countries signed a memorandum of understanding focused on:

- Digital health systems.
- Artificial Intelligence applications in healthcare.
- Medical technology.
- Health research and innovation.

This complements India's efforts under the Ayushman Bharat Digital Mission to build an integrated digital health ecosystem.

iii. Digital Development Cooperation

Digital cooperation emerged as another major area of partnership.

Focus Areas

- Digital Public Infrastructure (DPI).
- Digital Public Goods (DPGs).
- Technology-enabled governance.
- Inclusive digital development.

Indian Digital Platforms of Global Interest

- Aadhaar.
- UPI.
- DigiLocker.

This cooperation strengthens India's efforts to position Digital Public Infrastructure as a development model for emerging economies and the Global South.

h. Arctic Cooperation

Norway's Support for India's Arctic Engagement

- Norway reiterated support for India's scientific activities in the Arctic region.

Himadri Research Station

- India's Arctic research station, Himadri Research Station, serves as a key centre for polar research.

Importance of Arctic Cooperation

Research conducted in the Arctic contributes to understanding:

- Climate change dynamics.
- Cryosphere behaviour.
- Polar ecosystem changes
- Global weather systems.

For India, Arctic developments have significant implications for monsoon patterns, sea-level rise, and extreme weather events.

i. Maritime Cooperation and Blue Economy

i. Expanding Ocean-Based Cooperation

Both countries agreed to deepen cooperation in maritime affairs and sustainable ocean governance.

Areas of Collaboration

- Blue Economy initiatives.
- Maritime security.

- Capacity building.
- Marine resource management.
- Sustainable shipping.

This aligns closely with India's vision of Security and Growth for All in the Region (SAGAR) and its broader Indo-Pacific maritime strategy.

ii. Why Norway is Important

Norway's expertise in:

- Shipping.
- Offshore energy.
- Ocean governance.
- Maritime technology.

provides valuable opportunities for India's maritime sector.

j. Triangular Development Cooperation

i. A New Dimension of Partnership

A notable feature of the partnership is the agreement on triangular development cooperation.

Under this model, India and Norway will jointly support development initiatives in third countries, particularly across the Global South.

Potential Areas

- Digital Public Infrastructure.
- Governance reforms.
- Capacity building.
- Sustainable development projects.

This reflects India's transition from being primarily a recipient of development assistance to becoming an active development partner.

k. Shared Vision on Global Governance

Common Principles

India, Sweden, and Norway have reaffirmed their commitment to a rules-based international order founded upon:

- Sovereign equality.
- Respect for international law.
- Peaceful resolution of disputes.
- Dialogue and diplomacy.

This position acquires greater significance amid ongoing geopolitical tensions in regions such as Ukraine and West Asia.

Support for Governance Reform

The partnerships reinforce India's advocacy for:

- More representative global institutions.
- Inclusive multilateralism.
- Effective international cooperation.
- Reform of global governance structures.

l. Significance for India

Accelerating Green Industrialisation

The partnerships provide access to:

- Advanced technologies.
- Sustainable finance.
- Research collaborations.
- Industrial innovation.

These inputs are crucial for India's transition towards a low-carbon economy.

Strengthening India's Climate Leadership

India's role as a global climate actor is reinforced through initiatives such as:

- International Solar Alliance.
- Global Biofuels Alliance.
- Mission LiFE.
- LeadIT.

Supporting Viksit Bharat 2047

Green growth partnerships contribute to:

- Manufacturing competitiveness.
- Energy security.
- Sustainable infrastructure.
- Employment generation.
- Technological advancement.

Enhancing Climate and Arctic Research

Improved scientific cooperation will enhance India's understanding of:

- Monsoon variability.
- Glacial changes.
- Sea-level rise.
- Extreme weather events.

Expanding India's Role in the Global South

The partnerships strengthen India's emergence as:

- A technology provider.
- A development partner.
- A climate negotiator.
- A bridge between developed and developing nations.

m. Challenges

Challenge	Implication
Technology Access Barriers	High costs and intellectual property constraints
Climate Finance Gaps	Insufficient funding for developing countries

Green Protectionism	Carbon border measures may affect exports
Supply Chain Vulnerabilities	Dependence on critical minerals and technologies
Geopolitical Uncertainty	Potential disruption of international cooperation

Addressing these constraints will be critical for translating partnership commitments into tangible outcomes.

n. Way Forward

Strengthening International Cooperation

India should work with Sweden, Norway, and other like-minded partners to expand LeadIT and promote practical implementation of industrial decarbonisation projects.

There is also a need to advocate equitable climate finance mechanisms and facilitate greater technology sharing between developed and developing countries.

Accelerating Domestic Green Transformation

India must:

- Promote green manufacturing.
- Build resilient clean-energy supply chains.
- Invest in green skills and workforce development.
- Strengthen research and innovation ecosystems.

Deepening Strategic Engagement with Nordic Countries

The Nordic region offers substantial opportunities in:

- Clean energy.
- Maritime technology.
- Digital governance.
- Arctic science.
- Sustainable urbanisation.

A broader Nordic strategy can complement India's long-term developmental and geopolitical objectives.

Conclusion

The India–Sweden and India–Norway partnerships represent a new generation of international cooperation centred on green growth, technological innovation, and sustainable development. By combining India's scale, developmental experience, and market potential with Nordic expertise in clean technology, finance, and sustainability, these partnerships can accelerate India's transition towards a low-carbon economy. More importantly, they demonstrate how climate action, industrial competitiveness, and economic development can advance together, supporting India's vision of Viksit Bharat 2047 and its commitment to achieving net-zero emissions by 2070.

GS Paper II: Current Affairs

3. Decentralised Bioenergy Systems for India's Energy Security

a. Introduction

As concerns over energy security, volatile global fuel prices, climate change, and waste management intensify, bioenergy is emerging as a promising solution capable of addressing multiple challenges simultaneously. Technologies such as gasification and anaerobic digestion can convert agricultural residues, municipal organic waste, food waste, livestock waste, and sewage sludge into useful forms of energy.

For a country like India, which possesses abundant biomass resources while remaining dependent on imported fossil fuels, decentralised bioenergy systems offer a pathway towards energy self-reliance, rural development, environmental sustainability, and a circular economy.

b. Background

i. India's Energy Challenge

India's energy demand continues to grow rapidly alongside economic development and urbanisation. Despite significant progress in renewable energy deployment, the country remains heavily dependent on imported crude oil, natural gas, and coal.

Consequences of Import Dependence

- Global price volatility.
- Geopolitical disruptions.
- Supply-chain uncertainties.
- Foreign exchange pressures.

At the same time, India generates enormous quantities of biodegradable waste that often remain underutilised or are disposed of in environmentally harmful ways.

ii. Major Sources of Biomass and Organic Waste

Source	Examples
Agricultural Waste	Crop residues, straw, husk, stalks
Municipal Waste	Food waste and biodegradable waste
Industrial Waste	Organic processing residues
Livestock Waste	Animal manure
Sewage Waste	Sludge from treatment plants

The challenge, therefore, is not merely waste disposal but the efficient utilisation of these resources to generate energy and economic value.

c. India's Bioenergy Potential

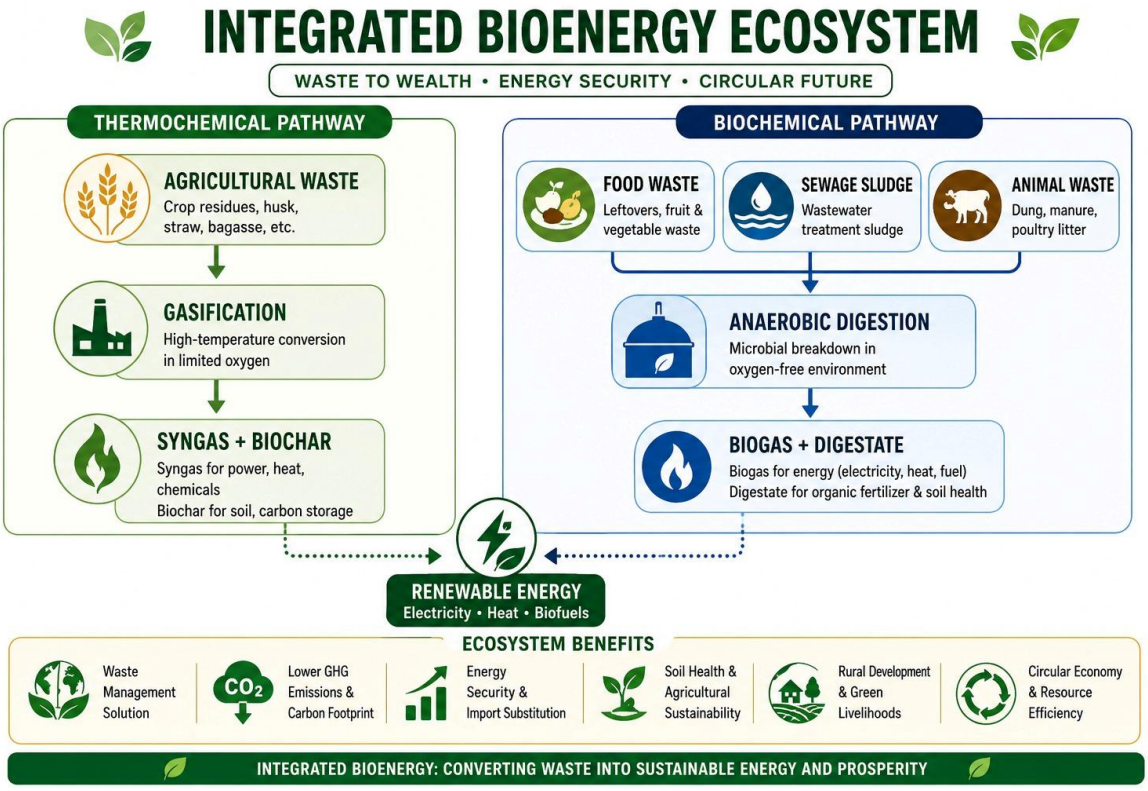
India possesses one of the world's largest biomass resource bases.

Key Facts

Indicator	Details
Annual Agricultural Biomass Generation	Approximately 750 million tonnes

Surplus Biomass Available	Approximately 230 million tonnes
Major Conversion Technologies	Gasification and Anaerobic Digestion
Key Government Initiative	SATAT Scheme

This vast resource base offers significant opportunities to reduce fossil fuel dependence while supporting rural livelihoods and environmental sustainability.



d. Understanding Bioenergy

i. Meaning of Bioenergy

Bioenergy refers to energy derived from biological materials of plant or animal origin.

Common Bioenergy Resources

- Agricultural residues.
- Forestry waste.
- Livestock waste.
- Municipal organic waste.
- Food processing waste.
- Sewage sludge.

Unlike fossil fuels, biomass can be replenished naturally, making bioenergy a renewable source of energy when managed sustainably.

ii. Unique Characteristics of Bioenergy

Multiple Benefits

- Energy production.
- Waste management.

- Climate mitigation.
- Rural income generation.
- Resource efficiency.

Bioenergy occupies a unique position because it simultaneously addresses energy production, waste management, and climate mitigation.

e. Technology I: Gasification

i. What is Gasification?

Gasification is a thermochemical process through which dry biomass is converted into a combustible gas known as synthesis gas or syngas.

Instead of burning biomass completely, gasification subjects it to high temperatures with a limited supply of oxygen, allowing partial oxidation and chemical transformation.

ii. Suitable Feedstock

- Crop residues.
- Husk and straw.
- Woody biomass.
- Agricultural waste.
- Dry organic waste.

iii. Process of Gasification

- Drying of biomass.
- Pyrolysis.
- Partial oxidation.
- Reduction reactions.

The process generally operates at temperatures ranging from 800°C to 1000°C under controlled oxygen conditions.

The restricted oxygen supply prevents complete combustion and enables the production of valuable gases.

iv. Output: Syngas

The primary output is syngas, a combustible mixture containing:

- Carbon Monoxide.
- Hydrogen.
- Carbon Dioxide.
- Methane.

v. Uses of Syngas

Application	Use
Electricity Generation	Decentralised power production
Industrial Heating	Thermal energy applications
Hydrogen Production	Clean fuel generation
Methanol Production	Chemical industry feedstock

Ethanol Production	Biofuel manufacturing
Renewable Methane	Substitute for natural gas

The versatility of syngas makes gasification an important technology for industrial decarbonisation and energy diversification.

vi. Biochar: An Important Co-product

Gasification also produces biochar, a carbon-rich solid residue.

Significance of Biochar

- Improves soil fertility.
- Enhances moisture retention.
- Promotes sustainable agriculture.
- Stores carbon for long periods.
- Supports carbon-credit generation.

Biochar therefore provides both agricultural and climate-related benefits, making gasification attractive from a circular economy perspective.

f. Technology II: Anaerobic Digestion

i. What is Anaerobic Digestion?

Anaerobic digestion is a biological process in which microorganisms break down organic matter in the absence of oxygen.

The process mimics natural decomposition but occurs within controlled conditions to maximise energy recovery.

ii. Suitable Feedstock

Anaerobic digestion is most suitable for wet organic materials such as:

Common Inputs

- Food waste.
- Sewage sludge.
- Animal manure.
- Dairy waste.
- Organic industrial waste.

iii. Outputs of Anaerobic Digestion

Biogas

The principal product is biogas, composed mainly of:

- Methane.
- Carbon Dioxide.

After purification, biogas can be upgraded into Compressed Biogas (CBG), which can serve as a substitute for conventional fossil fuels.

Digestate

The second major output is digestate, a nutrient-rich residue that can be used as:

- Organic fertiliser.
- Soil conditioner.

- Agricultural nutrient source.

Thus, anaerobic digestion converts waste into both energy and agricultural inputs.

iv. Applications of Anaerobic Digestion

Sector	Application
Urban Local Bodies	Municipal waste management
Dairy Industry	Manure treatment
Food Processing Industry	Waste-to-energy systems
Rural Areas	Cooking fuel and electricity
Sewage Treatment Plants	Energy recovery from sludge

The technology is particularly valuable for municipalities seeking to reduce landfill burdens while generating renewable energy.

g. Gasification and Anaerobic Digestion: Complementary Technologies

Parameter	Gasification	Anaerobic Digestion
Feedstock	Dry biomass	Wet organic waste
Nature of Process	Thermochemical	Biological
Main Product	Syngas	Biogas
Operating Temperature	High	Low to moderate
Typical Inputs	Crop residue and wood waste	Food waste and sewage
By-product	Biochar	Digestate

Gasification and anaerobic digestion should be viewed as complementary components of an integrated waste-to-energy ecosystem. Together, they can process India's diverse biomass resources more efficiently than either technology alone.

h. Significance for India

i. Strengthening Energy Security

Bioenergy can reduce dependence on imported fossil fuels by diversifying India's energy mix and utilising domestic resources.

Benefits

- Reduced import dependence.
- Improved energy resilience.

- Greater local energy production.
- Enhanced energy diversification.

A distributed network of bioenergy facilities can improve resilience against global energy market disruptions and strengthen long-term energy security.

ii. Addressing Stubble Burning

Agricultural residues that are currently burned in fields can instead be converted into useful energy products.

Positive Outcomes

- Reduction in air pollution.
- Lower particulate matter emissions.
- Improved public health.
- Additional income streams for farmers.

The issue is particularly relevant in northern India, where seasonal stubble burning contributes significantly to air-quality deterioration.

iii. Advancing the Circular Economy

Bioenergy exemplifies the principle of converting waste into wealth.

Valuable Outputs

- Electricity.
- Renewable fuels.
- Organic fertilisers.
- Carbon-sequestering products.

This improves resource efficiency and supports sustainable consumption patterns.

iv. Promoting Decentralised Development

One of the strongest arguments in favour of bioenergy is its suitability for decentralised deployment.

Potential Beneficiaries

- Rural communities.
- Agro-processing clusters.
- Micro, Small and Medium Enterprises (MSMEs).
- Remote regions.
- Local government bodies.

Advantages

- Reduced transportation costs.
- Improved local energy access.
- Employment generation.
- Community participation.
- Strengthened rural economies.

Decentralised systems also reduce transmission losses and improve energy availability in underserved areas.

v. Climate Change Mitigation

Bioenergy contributes to climate goals through multiple pathways.

Climate Benefits

- Reduction in fossil fuel consumption.

- Capture of methane emissions.
- Sustainable waste management.
- Carbon sequestration through biochar.

Consequently, bioenergy supports India's commitment to achieve net-zero emissions by 2070 and fulfil its obligations under the Paris Agreement.

i. Government Initiatives

i. Sustainable Alternative Towards Affordable Transportation (SATAT)

The SATAT initiative, launched by the Ministry of Petroleum and Natural Gas, aims to promote the production and utilisation of Compressed Biogas.

Objectives

- Utilisation of agricultural residues.
- Conversion of municipal waste into fuel.
- Promotion of cleaner transportation fuels.
- Reduction of fossil fuel imports.

ii. GOBAR-Dhan Scheme

The GOBAR-Dhan Scheme seeks to promote:

- Rural waste management.
- Biogas generation.
- Organic fertiliser production.
- Improved sanitation.

The initiative contributes simultaneously to energy generation and rural development.

iii. National Bioenergy Programme

The programme supports:

- Biomass-based power generation.
- Biogas projects.
- Waste-to-energy initiatives.
- Biofuel development.

It serves as the umbrella framework for promoting bioenergy deployment across the country.

j. Challenges

Challenge	Impact
Poor Waste Segregation	Reduced feedstock quality
Feedstock Collection Issues	Supply uncertainty
High Capital Costs	Slower investment
Technology Standardisation Gaps	Operational inefficiencies

Financing Constraints	Limited private participation
Weak Carbon Markets	Lower project viability
Low Awareness	Reduced adoption by communities and local bodies

Unless these challenges are addressed, bioenergy deployment may remain below its potential.

k. International Best Practices

Sweden

Sweden has developed advanced waste-to-energy systems integrated with efficient waste segregation and urban management practices.

Its success demonstrates how waste can become a major energy resource when supported by appropriate infrastructure and public participation.

Germany

Germany has built one of the world's largest biogas ecosystems through:

- Farm-based digesters.
- Community energy models.
- Stable policy incentives.
- Strong farmer participation.

Lessons for India

- Effective source segregation.
- Decentralised infrastructure.
- Long-term policy stability.
- Market-based incentives.
- Community ownership models.

l. Way Forward

i. Strengthening Waste Management Systems

Mandatory segregation at source and improved municipal collection systems are essential for ensuring reliable feedstock supply.

Waste management reforms must become an integral part of energy policy.

ii. Promoting Technological Innovation

India should encourage:

- Advanced gasification technologies.
- Efficient biogas upgrading systems.
- Biochar utilisation programmes.
- Indigenous research and development.

This will improve efficiency and reduce costs.

iii. Supporting Decentralised Bioenergy Ecosystems

District-level bioenergy planning should identify local biomass resources and create integrated waste-to-energy clusters.

Institutions Requiring Support

- Farmer Producer Organisations (FPOs).
- Cooperatives.
- MSMEs.
- Panchayati Raj Institutions.

iv. Expanding Green Financing

Greater access to concessional finance, viability gap funding, carbon markets, and blended finance mechanisms can improve project viability and attract private investment.

Conclusion

India possesses one of the world's largest untapped bioresource bases in the form of agricultural residues, municipal organic waste, livestock waste, and sewage sludge. Technologies such as gasification and anaerobic digestion provide viable pathways for transforming these resources into clean energy while generating valuable by-products such as biochar and organic fertilisers. By strengthening waste segregation, supporting decentralised energy systems, improving access to finance, and fostering technological innovation, India can transform its waste streams into engines of sustainable growth. In doing so, bioenergy can become a vital pillar of energy security, rural prosperity, circular economy development, and climate action in the decades ahead.

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.