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## GS Paper II: International Relations

### 1. International Solar Alliance: Structure, Role and the Implications of Major Power Withdrawal

#### a. Understanding the International Solar Alliance

The International Solar Alliance (ISA) is a treaty-based intergovernmental organisation established to promote the large-scale deployment of solar energy, particularly in developing countries located in the tropical belt.

The core challenge ISA seeks to address is not the availability of sunlight, but the capacity to convert solar potential into usable energy. Many developing countries possess abundant solar resources, yet face persistent barriers such as:

- High upfront capital costs
- Limited access to affordable and long-term finance
- Technological and skill deficits
- Weak regulatory and institutional frameworks

ISA was conceived as a collective mechanism to overcome these constraints. Its overarching objective is to make solar energy financially viable, technologically accessible and institutionally sustainable, especially for countries that are otherwise marginalised in the global clean energy transition.

#### b. Genesis and Institutional Profile

The International Solar Alliance was launched in 2015 as a joint diplomatic initiative by India and France, symbolising a partnership between climate leadership from the Global South and institutional support from an advanced economy. The framework agreement entered into force in 2017, following ratification by the required number of member states.

ISA is headquartered in Gurugram, Haryana, making it one of the few major international organisations based in India. Its membership has expanded to over one hundred countries, with strong representation from:

- Africa
- Asia
- Latin America
- Small Island Developing States

This wide and inclusive membership base has positioned ISA as a key pillar of India's climate diplomacy, South-South cooperation, and leadership among developing countries.

#### c. Functional Role of ISA: What It Does in Practice



ISA does not directly construct solar power plants or generate electricity. Instead, it operates as an enabling and facilitative platform that strengthens the overall ecosystem for solar deployment.

#### **Mobilisation of Finance**

- Works with multilateral development banks, sovereign funds and private investors
- Reduces perceived investment risks in developing countries
- Helps lower borrowing costs for solar projects

#### **Capacity Building**

- Supports training programmes for policymakers, regulators and technicians
- Enhances institutional readiness for solar planning and regulation

#### **Project Development and Aggregation**

- Promotes standardised project designs
- Aggregates demand across multiple countries
- Helps create bankable project proposals

Through these functions, ISA deepens South–South cooperation, enabling countries with similar developmental constraints to share solutions rather than pursue fragmented, isolated efforts.

#### **d. Financial Impact of Withdrawal by a Major Power**

From a narrow financial standpoint, the withdrawal of a single major country does not severely disrupt ISA's functioning.

- Member contributions form only a limited share of ISA's total resource pool
- Most programmes rely on multilateral institutions and pooled financing mechanisms
- Ongoing projects and administrative operations continue largely uninterrupted

As a result, ISA does not face an immediate funding crisis, project collapse or institutional paralysis due to such withdrawal.

#### **e. The Deeper Impact: Confidence and Credibility**

The more significant impact of a major power's withdrawal lies in the realm of confidence and perception.

Solar investments in developing and climate-vulnerable countries depend heavily on:

- Long-term concessional finance
- Stable political signals on climate commitment
- Positive risk assessments by international lenders

When a major power disengages from global or plurilateral climate initiatives, it can subtly weaken confidence in the durability of international climate cooperation. This may lead to:

- Greater caution among lenders
- Slower project approvals
- Higher cost of capital

These effects are felt most acutely by African countries, least-developed economies and small island states, which already face structural disadvantages in accessing global finance.

Thus, ISA's challenge becomes one of maintaining trust and momentum, rather than merely replacing lost funds.

## **f. Implications for India's Solar Manufacturing Ecosystem**

India's solar manufacturing sector remains largely insulated from such external developments.

- Growth is driven primarily by strong domestic demand
- Supported by consistent policy measures and production-linked incentives
- Gradual expansion across cells, modules and early-stage upstream components

Crucially, India's solar manufacturing ecosystem does not depend on any single external country for market access or critical inputs. Therefore, withdrawal from ISA by another country does not directly:

- Raise production costs
- Disrupt supply chains
- Slow domestic capacity expansion

## **g. Impact on Solar Investments Within India**

Solar investments in India are unlikely to be affected in the short to medium term.

- Most large projects are backed by long-term power purchase agreements
- Revenue certainty is ensured through central and state agencies
- Investor confidence is anchored in structural fundamentals

Key drivers such as rising electricity demand, policy continuity and tariff visibility remain intact. As a result, domestic solar deployment continues on a strong and stable trajectory.

## **h. Indirect Challenges for India**

The subtler challenge lies in external markets, particularly in developing regions.

- ISA has helped open solar opportunities in Africa and other Global South regions
- Indian firms have leveraged these platforms to expand overseas

If confidence weakens and project pipelines slow in these regions:

- Indian companies may face fewer international opportunities
- India's role as a facilitator of South-led climate solutions becomes diplomatically more demanding

This represents a strategic and leadership challenge, rather than an immediate economic disruption.

## **i. Implications for Global Climate Governance**

Such episodes reflect a trend towards a more fragmented and decentralised climate governance system.

- Leadership by major powers has become less predictable
- Greater responsibility shifts to middle powers and developing country coalitions

In this context, platforms like ISA gain importance as vehicles for collective action. However, this also places greater pressure on them to deliver results despite constrained resources and uncertain geopolitical backing.

For India, this dual reality increases both its influence and responsibility in shaping global climate outcomes.

## **j. Way Forward**

Going ahead, ISA must prioritise:

- Strengthening innovative climate finance instruments, such as blended finance and credit guarantees
- Shielding vulnerable countries from fluctuations in global political commitment

India can reinforce ISA by:

- Diversifying partnerships with European countries and multilateral development banks
- Engaging regional financial institutions
- Maintaining domestic credibility through progress in grid integration, energy storage and transmission expansion

By consolidating ISA as a dependable platform for the Global South, India can transform a moment of uncertainty into an opportunity for sustained and credible climate leadership.

### Conclusion

The International Solar Alliance represents a novel model of climate cooperation led by the Global South, focused on practical solutions rather than abstract commitments. While withdrawal by a major power may not weaken its finances, it tests the Alliance's credibility and momentum. For India, this moment underscores both a challenge and an opportunity—to reinforce ISA through innovation, partnerships and delivery, and to consolidate its role as a credible leader in shaping an equitable global energy transition.

## GS Paper III: Security

### 2. Hypersonic Missiles in India: LR-AShM and Emerging Capabilities

#### a. Understanding Hypersonic Missiles: Starting from the Basics

Hypersonic missiles are weapon systems capable of travelling at speeds exceeding Mach 5, that is, five times the speed of sound. At such extreme velocities, a missile can traverse hundreds or even thousands of kilometres within minutes, leaving the adversary with very limited reaction time.

However, speed alone does not define hypersonic weapons. Their strategic significance flows from the combined effect of three factors:

- Extreme velocity, which compresses detection and response timelines
- In-flight manoeuvrability, allowing course corrections during flight
- Reduced predictability and detectability, especially by conventional radar systems

Unlike traditional ballistic missiles that follow relatively predictable paths, hypersonic weapons can change direction mid-course and often operate at lower altitudes within the atmosphere. This makes their trajectories difficult to calculate, thereby undermining the effectiveness of existing missile defence systems.



## **b. Broad Classification of Hypersonic Weapons**

Conceptually, hypersonic weapons are divided into two major categories, based on their mode of propulsion and flight behaviour.

### **i. Hypersonic Glide Vehicles (HGVs)**

A hypersonic glide vehicle is initially launched using a rocket booster, which accelerates it to very high speed and altitude. After this boost phase:

- The glide vehicle separates from the rocket
- It re-enters the atmosphere
- It glides unpowered at hypersonic speeds while manoeuvring laterally and vertically

This glide phase allows the weapon to follow an unpredictable, non-linear path, significantly complicating interception.

### **ii. Hypersonic Cruise Missiles (HCMs)**

Hypersonic cruise missiles operate entirely within the atmosphere and rely on advanced air-breathing engines, particularly scramjets, to maintain hypersonic speed throughout their flight.

These systems represent the most technologically demanding class of hypersonic weapons due to challenges related to propulsion stability, combustion, and heat management at extreme speeds.

India's Long Range Anti-Ship Missile (LR-AShM) falls under the hypersonic glide vehicle category.

## **c. Long Range Anti-Ship Hypersonic Missile (LR-AShM): An Overview**

The Long Range Anti-Ship Hypersonic Missile (LR-AShM) is an indigenously developed weapon system designed by the Defence Research and Development Organisation (DRDO) to meet the long-range maritime strike requirements of the Indian Navy.

The missile is specifically intended to neutralise high-value enemy naval assets, including major surface combatants, operating far from India's coastline. Its development represents a significant milestone in India's transition towards advanced, indigenous, precision-strike capabilities in the maritime domain.

## **d. Key Characteristics of LR-AShM**

The LR-AShM integrates range, speed, manoeuvrability, and precision into a single platform.

### **Extended Range**

- Operational range of approximately 1,500 km
- Scope for longer-range variants in the future

### **Hypersonic Speed**

- Achieves extremely high speeds soon after launch
- Maintains hypersonic velocity for most of its flight

### **Target Engagement Capability**

- Capable of striking both static and moving naval targets
- Essential for modern anti-ship warfare, where targets are rarely stationary

### **Trajectory and Propulsion**

- Follows a quasi-ballistic trajectory
- Powered by a two-stage solid rocket motor

## **Deployment Vision**

- Current focus on naval and coastal defence roles
- Planned variants for the Army and Air Force under a joint-services framework

## **e. The Concept of a Quasi-Ballistic Flight Path**

Traditional ballistic missiles follow a high-altitude, smooth parabolic arc. Once detected, their trajectory can be calculated with reasonable accuracy, allowing missile defence systems to plan interception.

In contrast, a quasi-ballistic hypersonic missile:

- Begins with a ballistic-like boost phase
- Transitions to lower atmospheric flight
- Executes continuous manoeuvres during the glide phase

This hybrid behaviour combines the launch characteristics of ballistic missiles with the unpredictability of atmospheric flight. The result is a constantly changing trajectory that defies easy prediction, severely complicating defensive responses.

## **f. Challenges in Detection and Interception**

The LR-AShM strains conventional air and missile defence architectures due to multiple reinforcing factors.

### **Low-Altitude Flight**

- Reduces early detection by radar systems
- Radar coverage is constrained by the curvature of the Earth

### **Extreme Speed**

- Compresses decision-making timelines to minutes or seconds
- Leaves little scope for layered defensive responses

### **Continuous Manoeuvring**

- Prevents accurate prediction of impact point
- Undermines interceptor guidance algorithms

### **Atmospheric Flight Profile**

- Avoids tracking systems optimised for high-altitude ballistic threats

Taken together, these features make hypersonic glide weapons among the most difficult threats to counter in contemporary warfare.

## **g. Strategic Significance for India**

### **i. Maritime Security and Sea Denial**

LR-AShM significantly strengthens India's sea-denial capability, enabling it to prevent adversary naval forces from operating freely in critical maritime spaces. This is especially relevant in the Indian Ocean Region, where control over sea lanes is central to national security.

### **ii. Enhancing Deterrence**

A credible hypersonic anti-ship capability raises the cost of hostile naval operations by placing even well-defended, high-value warships at risk. This contributes to deterrence by uncertainty and denial.

### **iii. Operational Flexibility and Jointness**

Planned induction across all three services aligns with India's emphasis on joint operations and integrated theatre commands, providing rapid response options across domains.

### **h. India's Broader Hypersonic Technology Ecosystem**

The development of LR-AShM reflects advances in several foundational technologies:

- High-temperature materials capable of withstanding extreme thermal stress
- Advanced guidance, navigation and control systems at hypersonic speeds
- Precision targeting under severe aerodynamic conditions

Parallel efforts are underway in hypersonic cruise missile development, which relies on scramjet propulsion.

A key propulsion distinction is important:

- Ramjets operate efficiently at lower supersonic speeds
- Scramjets are designed for sustained operation beyond Mach 5

Scramjets involve complex airflow management, combustion stability, and thermal control, making them among the most challenging propulsion systems in aerospace engineering.

### **i. India in the Global Hypersonic Landscape**

Globally, only a small group of states have demonstrated credible hypersonic weapon capabilities. India's progress reflects:

- Maturation of indigenous research and development
- Growing depth in advanced materials and propulsion science
- Alignment with the broader push for strategic autonomy and self-reliance

This trajectory reduces long-term dependence on external suppliers in a domain that is increasingly central to future warfare.

### **j. Way Forward**

India's hypersonic journey must prioritise:

- Faster integration of sensors, guidance systems, and warhead technologies
- Timely induction across all three services to ensure operational credibility
- Sustained investment in materials science and propulsion research

Equally important is the integration of hypersonic weapons into a network-centric operational framework, combining satellite surveillance, real-time intelligence, and maritime domain awareness. Such integration will ensure that hypersonic capabilities function not as standalone assets, but as a core component of India's evolving deterrence and maritime security doctrine.

### **Conclusion**

The LR-AShM represents a major leap in India's maritime strike and deterrence capabilities, combining hypersonic speed with manoeuvrability to challenge existing naval defences. Beyond a single missile system, it reflects India's growing technological maturity in hypersonic warfare and strengthens its ability to safeguard strategic interests, particularly in the maritime domain.

## 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:

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- lists
- tables
- visual cues

—all optimised for retention.

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### 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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