

Topic - What is orange economy??(GS-3 ECONOMICS)

Modi champions 'orange economy' at WAVES

Vinaya Deshpande Pandit
MUMBAI

Appealing to global companies to create content in India, Prime Minister Narendra Modi on Thursday said that the strength of Indian culture was to respect the cultures of other countries.

"This is the right time for 'create in India, create for the world'. Global content will be respected here. I want to give confidence to everyone from outside that when you come here, you will get connected to India very naturally. India is becoming an orange economy. The Parsis, the Jews came here and became a part of our country. The strength of our culture is to respect the cultures of the other countries," Mr. Modi said, speaking at the inauguration of the WAVES summit at Mumbai's Jio World Centre.

The 'orange economy', also known as the creative economy, refers to economic activities that lever-

age creativity, culture, and intellectual property to generate wealth and jobs.

Mr. Modi hailed Indian content creators, and stressed the importance of responsible creativity. "Today, foreign consumers are consuming Indian entertainment with subtitles. Screen size is becoming smaller, but the consumption is growing, the message is becoming bigger. In this time of a booming orange economy, I want to tell all you content creators, you are bringing a new wave to India's creativity. Our government is with you in your efforts," he said.

"Extra efforts need to be taken to take care of human sensitivities and sensibilities. We want to enrich humans and not turn them into robots," Mr. Modi said.

Cultural waves

The WAVES, or World Audio Visual and Entertainment Summit, has attracted major names from the media and entertainment



PM's pitch: Narendra Modi addressing the World Audio Visual Entertainment Summit 2025 in Mumbai on Thursday. PHO

industry from over 90 countries, including superstar actor Rajinikanth and Reliance Industries' CEO and MD Mukesh Ambani, who both paid respects to the victims of the recent terror attack in Pahalgam in Jammu and Kashmir.

Lauding the Prime Minister, the two said the country stood with him.

"Many said, the government will postpone this event as it is about entertainment. But I was sure that this event will happen. I am confident about our

Prime Minister. He is a fighter. My hearty congratulations to the government and to the media industry. Extending my support always. Thank you for the opportunity," Mr. Rajinikanth said.

"WAVES highlights India's creative strength on the global platform. WAVES is not just an acronym, it is a wave of culture, creativity and universal connectivity," said Mr. Modi, announcing that India will soon launch the WAVES Awards.

Mr. Ambani said that the current valuation of India's entertainment industry is \$28 billion. "It will reach \$100 billion over the next few years. Let the stories flow, let the WAVES rise," he said.

'Creativity boom'

Adobe CEO Shantanu Narayen said. "The next boom of India is not in software, but in creativity and entertainment. With the unmatched talent in this country, India's creative economy is poised to employ more than in manufacturing industry. Over a billion people have used Adobe. A majority being used in India is being used to empower teachers. The intent is to reach two crore students and five lakh teachers. Our collaboration with WAVES will take Indian talent global."

The inaugural song at the event, showcasing India's spirituality and diversity, was composed by Oscar winning composer M.M. Keeravani.



□ The orange economy, also known as the creative economy, refers to the sector of the economy that is based on creativity, culture, and the arts. It includes industries where cultural knowledge, artistic expression, and intellectual property are the main sources of value.

Key components of the orange economy include:

- Art (visual arts, performing arts)
- Music
- Film and television

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- **Fashion and design**
 - **Advertising and media**
 - **Architecture**
 - **Publishing**
 - **Software and video games**
 - **Crafts and cultural heritage**

Why it matters:

- **It drives innovation and job creation.**
- **Promotes cultural identity and diversity.**
- **It's often sustainable and exportable, especially in digital formats.**

The term "orange economy" was popularized by a 2013 report by the Inter-American Development Bank (IDB), highlighting its potential in Latin America and the Caribbean, where "orange" is associated with culture and creativity.

Which of the following industries are part of the Orange Economy?

1. Architecture

2. Software development

3. Oil and Gas

4. Visual Arts

Select the correct answer using the code below:

A) 1 and 3 only

B) 1, 2, and 4 only

C) 2, 3, and 4 only

D) All of the above

Answer: B

Explanation: Oil and Gas is part of the conventional economy, not the orange economy. Architecture, software, and visual arts are part of the creative sector.



Topic → WAVES: World Audio Visual & Entertainment Summit 🌍

WAVES Media and Entertainment Cultural Diversity
Innovation Global Partnerships

Overview of WAVES

🌍 **Global Event: The World Audio Visual & Entertainment Summit (WAVES)** is an annual event aimed at establishing **India** as a key hub for the media and entertainment industry.

🎭 **Cultural Diversity:** Emphasizes cultural diversity, providing a platform for discussions among media CEOs, entertainment icons, and creative professionals.

 **Focus Areas:** Key topics include advancements in **animation, gaming, entertainment technology**, and both regional and mainstream cinema.

 **Partnerships:** Designed to foster partnerships and enhance India's creative economy on an international scale.

 **Event Rescheduling:** The inaugural edition was postponed and is now scheduled for **May 1 to 4, 2025**, at the **Jio World Convention Centre** in Mumbai.

 **Innovation and Protection:** Aims to enhance **intellectual property protection**, encourage innovation, and strengthen industry collaboration.

 **Investment Attraction:** Focuses on attracting investment, fostering skill development, and positioning India as a global leader in the media and entertainment sector.

Summary: WAVES is a global summit aimed at establishing India as a media and entertainment hub, focusing on cultural diversity, innovation, and international partnerships, now scheduled for May 2025.

Topic → U.S. signs deal to access rare earth minerals

in Ukraine(GEOGRAPHY)

saurabh pandey upsc

U.S. signs deal to access rare earth minerals in Ukraine

Associated Press

WASHINGTON

The U.S. and Ukraine on Wednesday signed an agreement granting American access to Ukraine's vast mineral resources, finalising a deal months in the making that could enable continued military aid to Kyiv amid concerns that U.S. President Donald Trump might scale back support in ongoing peace negotiations with Russia.

All about Ukraine-U.S. critical minerals deal

Reuters

Ukraine and the United States on Wednesday signed a deal heavily promoted by U.S. President Donald Trump that will give the United States preferential access to new Ukrainian minerals deals and fund investment in Ukraine's reconstruction.

The following is an overview of the critical minerals, including rare earths, and other natural resources in Ukraine:

What are rare earths and their usage?

Rare earths are a group of 17 metals used to make magnets that turn power into motion for electric vehicles, cell phones, missile systems, and other electronics. There are no viable substitutes.

The U.S. Geological Sur-



Huge stakes: The Ukrainian government estimates the sector's total investment potential at about \$12-15 billion by 2033. REUTERS

vey considers 50 minerals to be critical, including rare earths such as nickel and lithium. Critical minerals are essential for industries such as defence, high-tech appliances, aerospace and green energy.

Ukraine's resources

Ukraine has deposits of 22 of the 34 minerals iden-

tified by the European Union as critical, according to Ukrainian data. They include industrial and construction materials, ferro alloy, precious and non-ferrous metals, and some rare earth elements.

According to Ukraine's Institute of Geology, the country possesses rare

earths such as lanthanum and cerium, used in TVs and lighting; neodymium, used in wind turbines and EV batteries; and erbium and yttrium, whose applications range from nuclear power to lasers. EU-funded research indicates Ukraine has scandium reserves.

The World Economic Forum said Ukraine is also a key potential supplier of lithium, beryllium, manganese, gallium, zirconium, graphite, apatite, fluorite and nickel. The State Geological Service said Ukraine has one of Europe's largest confirmed reserves, estimated at 5,00,000 metric tonne of lithium – vital for batteries, ceramics, and glass.

The country has titanium reserves, mostly located in its northwestern and central regions, while lithi-

um is found in the centre, east and southeast.

Ukraine's reserves of graphite, a key component in electric vehicle batteries and nuclear reactors, represent 20% of global resources. The deposits are in the centre and west.

Ukraine also has significant coal reserves, though most are now under the control of Russia in occupied territory. Mining analysts and economists say Ukraine currently has no commercially operational rare earth mines. China is the world's largest producer of rare earths and many other critical minerals.

About the deal

The two countries signed the accord in Washington after months of sometimes fraught negotiations, with uncertainty persisting until the last mo-

ment with word of an eleventh-hour snag. The accord establishes a joint investment fund for Ukraine's reconstruction as Mr. Trump tries to secure a peace settlement in Russia's war in Ukraine.

U.S. Treasury Secretary Scott Bessent and Ukrainian First Deputy Prime Minister Yulia Svyrydenko were shown signing the agreement in a photo posted on X by the Treasury.

Oleksiy Sobolev, First Deputy Economy Minister, said in January the government was working on deals with Western allies including the United States, Britain, France and Italy on projects related to exploiting critical materials. The government estimates the sector's total investment potential at about \$12-15 billion by 2033.

why in news??

The U.S. and Ukraine on signed an agreement granting American access to Ukraine's vast mineral resources, finalising a deal months in the making that could enable continued military aid to Kyiv

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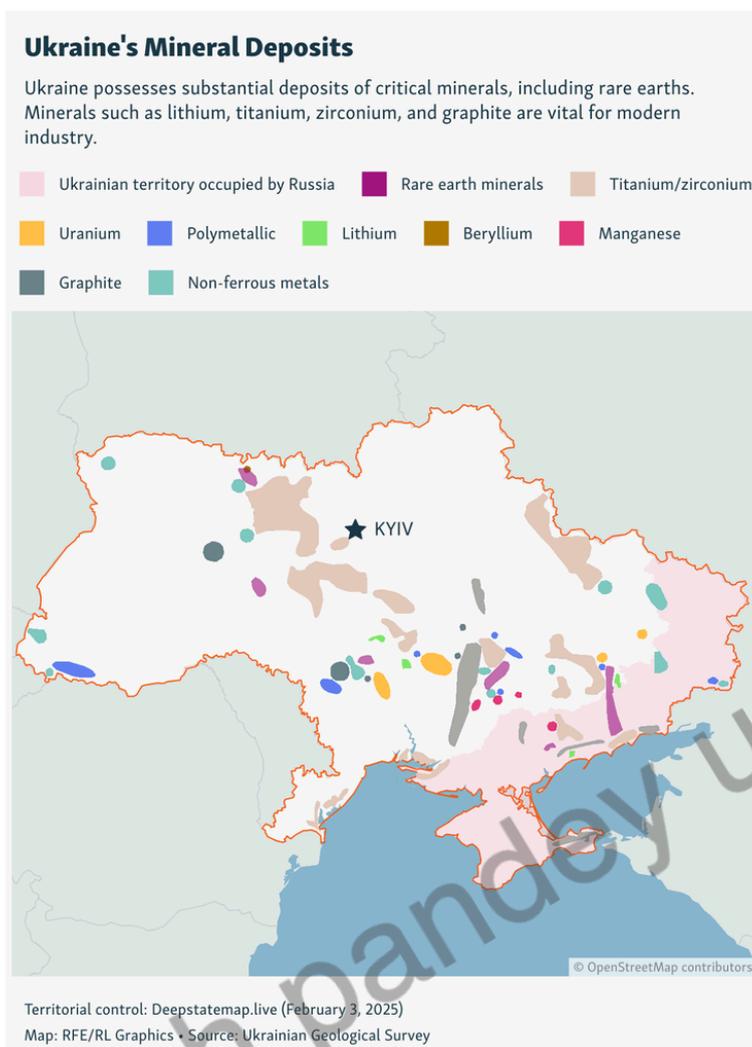
Critical mineral deposits across Ukraine

■ Titanium, zirconium ■ Graphite ■ Rare earths ■ Lithium



Note: Russia annexed Crimea in 2014

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Topic → Rare earth minerals

Rare earth minerals are naturally occurring minerals that contain one or more **rare earth elements (REEs)** — a group of **17 chemically similar elements** in the periodic table. Despite their name, most rare earth elements are **relatively abundant** in the Earth's crust, but they are rarely found in economically exploitable concentrations, which makes their **extraction complex and costly**.

✓ List of Rare Earth Elements (REEs):

They are divided into two categories:

1. Light Rare Earth Elements (LREEs):

- Lanthanum (La)
- Cerium (Ce)
- **Praseodymium (Pr)**
- **Neodymium (Nd)**
- **Promethium (Pm) (radioactive and rare)**
- **Samarium (Sm)**

2. Heavy Rare Earth Elements (HREEs):

- **Europium (Eu)**
- **Gadolinium (Gd)**
- **Terbium (Tb)**
- **Dysprosium (Dy)**
- **Holmium (Ho)**
- **Erbium (Er)**
- **Thulium (Tm)**
- **Ytterbium (Yb)**
- **Plus: Scandium (Sc) and Yttrium (Y) are often included due to similar properties**

🌍 Key Uses of Rare Earth Minerals:

- **Electronics: Smartphones, computers, and televisions**
-

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- **Green Technology:** Wind turbines, electric vehicle batteries, solar panels
 - **Defense:** Guided missiles, radar, lasers
 - **Magnets:** High-performance permanent magnets (NdFeB magnets)
 - **Glass & Ceramics:** Polishing powders, UV protection, colorants
-

Q Consider the following statements about Rare Earth Elements (REEs):

1. They are found in high concentrations and are easy to extract.

2. China is the world's largest producer of rare earths.

3. Rare earths are essential for green technologies like wind turbines and electric vehicles.

Which of the above statements is/are correct?

A) 1 and 2 only

B) 2 and 3 only

C) 1 and 3 only

D) All of the above

Answer: B

Explanation: Statement 1 is incorrect — although REEs are abundant, they are rarely found in extractable concentrations.

**TOPIC → Vizhinjam Port (GS Paper III:
Infrastructure, Economic
Development)**

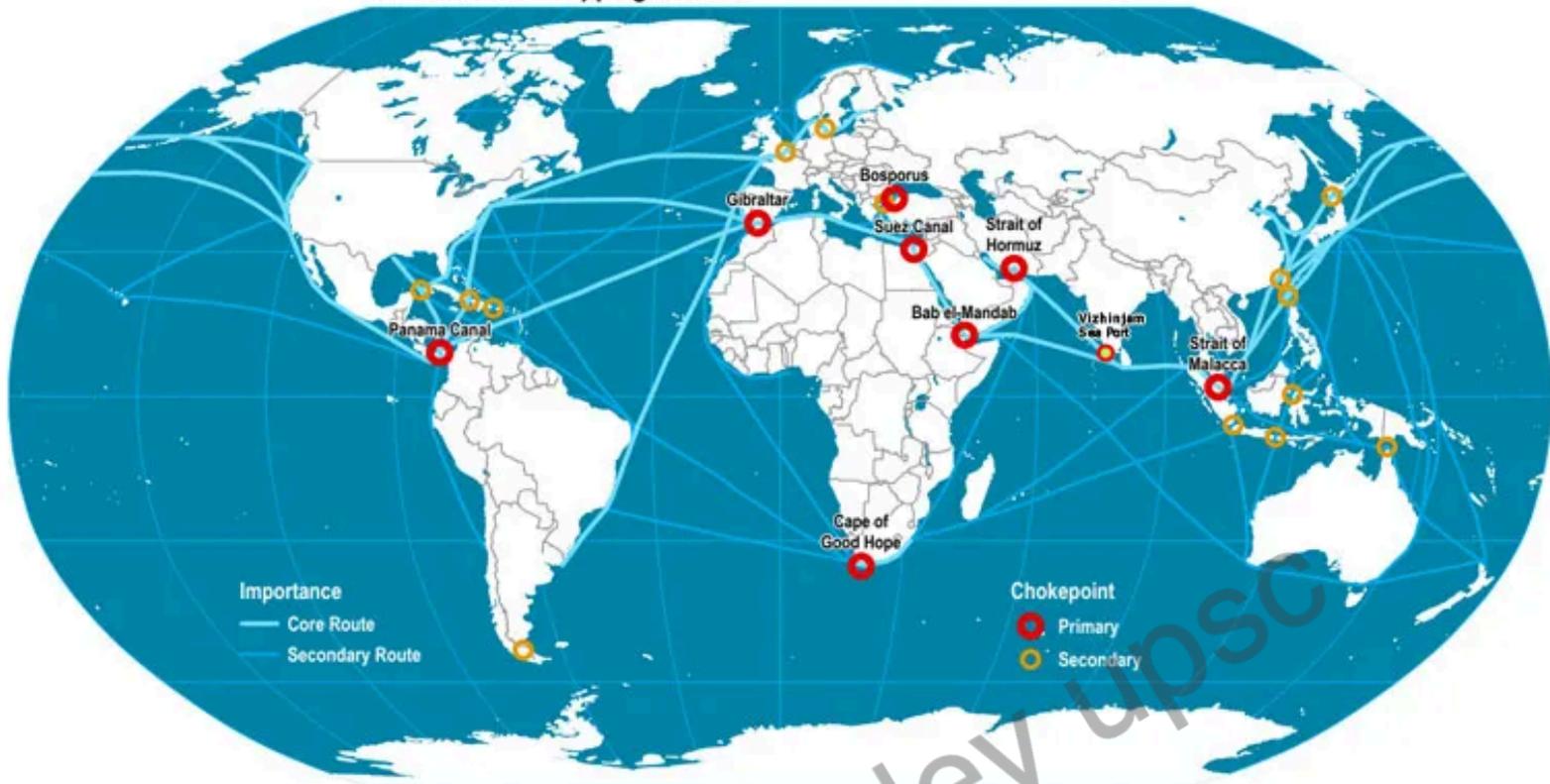


**Vizhinjam port to
boost South Asia's
maritime trade**

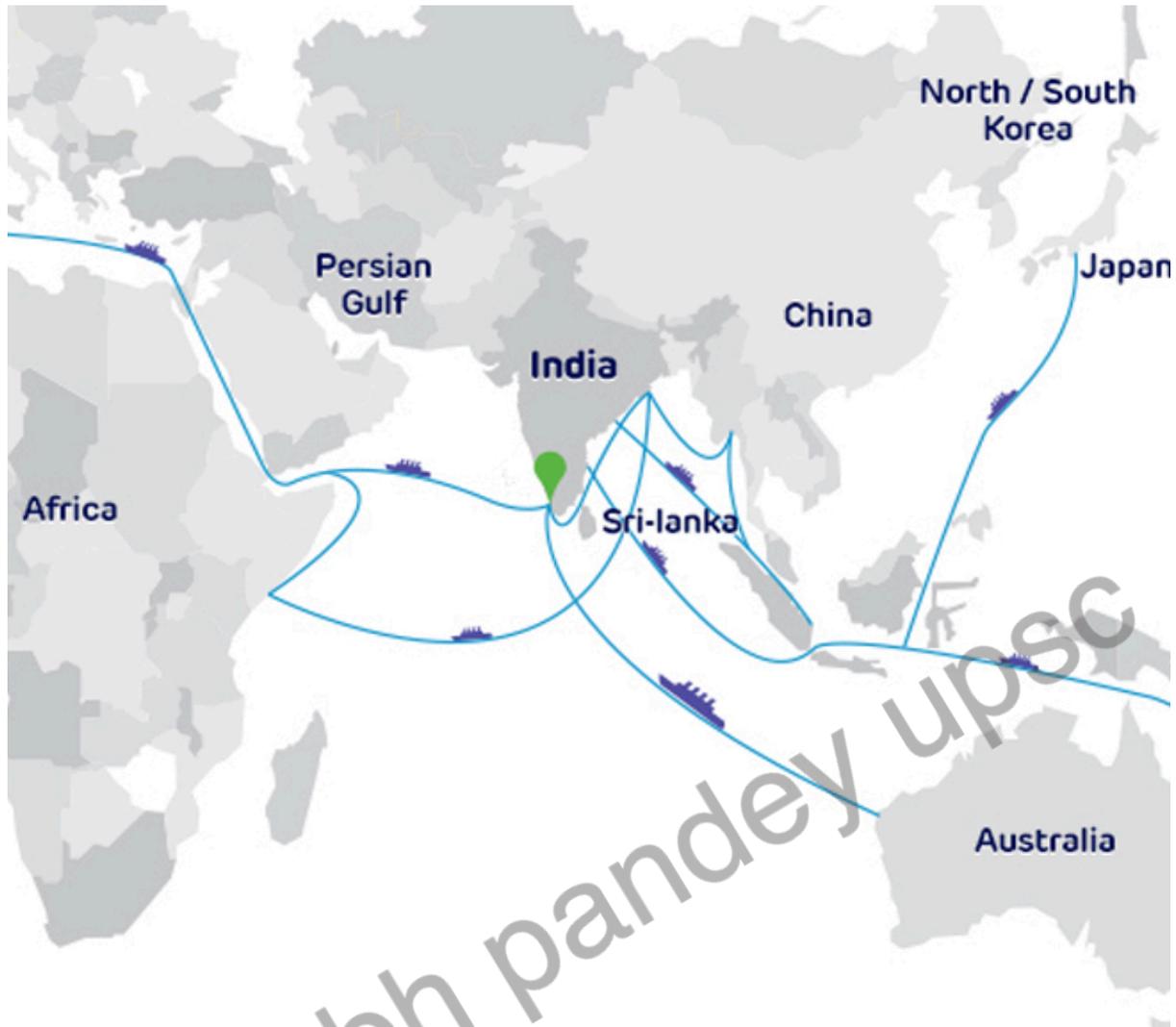
THIRUVANANTHAPURAM

Prime Minister Narendra Modi
will dedicate to the country the
ambitious Vizhinjam
International Seaport project

Main Maritime Shipping Routes



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TRANSHIPMENT PROCESS

Port of Origin



E.g. Los Angeles, California



Shipping to transshipment hub



Transshipment Hub



E.g. Port of Singapore



Shipping to destination port



Destination Port



E.g. Sydney, Australia



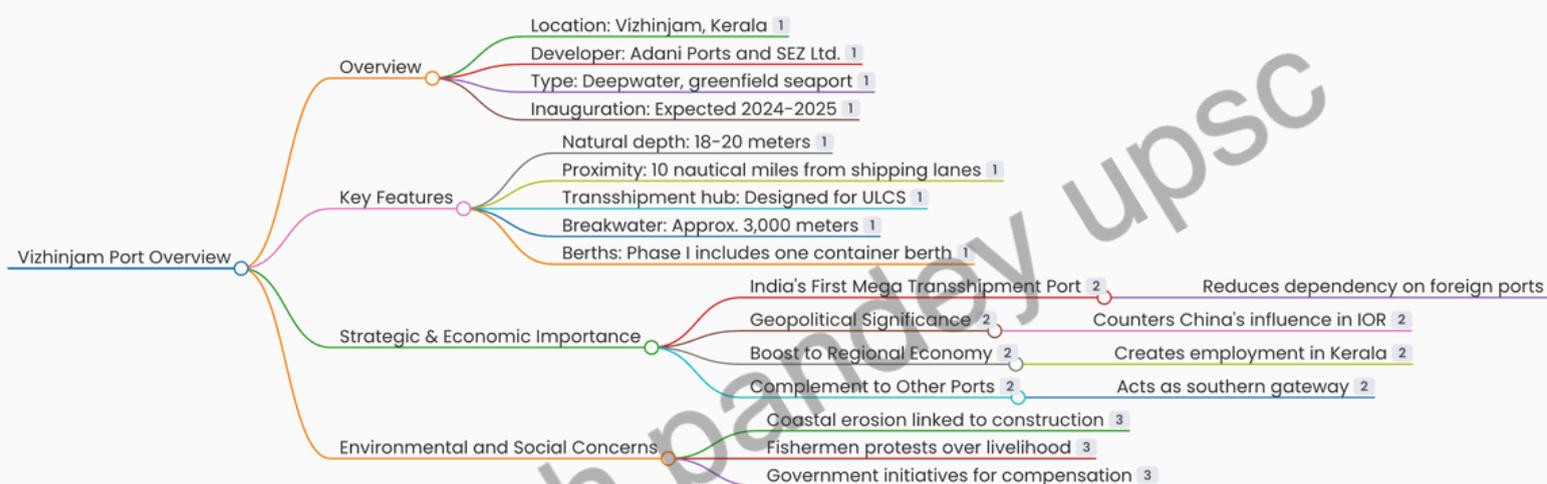
[Vizhinjam Port – Overview](#)

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- **Vizhinjam Port, located near Thiruvananthapuram, Kerala, is being developed by Adani Ports and SEZ Ltd. in partnership with the Kerala Government under a Public-Private Partnership (PPP) model.**
 - **This deepwater, all-weather greenfield seaport is expected to become operational in 2024-2025, having faced delays from earlier timelines .**
 - **The port features a natural depth of 18-20 meters, making it suitable for Ultra Large Container Ships (ULCS), and is strategically positioned just 10 nautical miles from major international shipping lanes**

Strategic & Economic Importance

- **Vizhinjam Port is poised to be India's first mega transshipment port, which will help reduce the country's reliance on foreign ports like Colombo, Singapore, and Port Klang (Port Klang is the principal port of Malaysia on the Strait of Malacca) for transshipment, thereby retaining maritime revenue within India .**
 - **The port also holds geopolitical significance as it aids India in countering China's influence in the Indian Ocean Region (IOR) and enhances the country's maritime positioning under initiatives like Sagarmala and Maritime India Vision .**
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- **Additionally, it is expected to boost the regional economy by creating direct and indirect employment opportunities in Kerala and stimulating infrastructure, logistics, and tourism development in the southern part of the state**
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✓ GS Paper III – Infrastructure & Economy

Q "Vizhinjam Port is a strategic infrastructure project, not merely a commercial endeavor."

Examine the economic and strategic importance of Vizhinjam International Seaport for India's maritime trade and port-led development initiatives. (250 WORDS)

TOPIC - NON CONTACT WEARABLE TECHNOLOGY

A 'non-contact' wearable that uses skin flux to monitor health

The device is just about the size of a smartphone face and has demonstrated unique capabilities to measure the flux of water vapour, volatile organic compounds and carbon dioxide at various locations on the body; according to researchers, it is unique because the sensors don't contact skin

Ramya Kannan

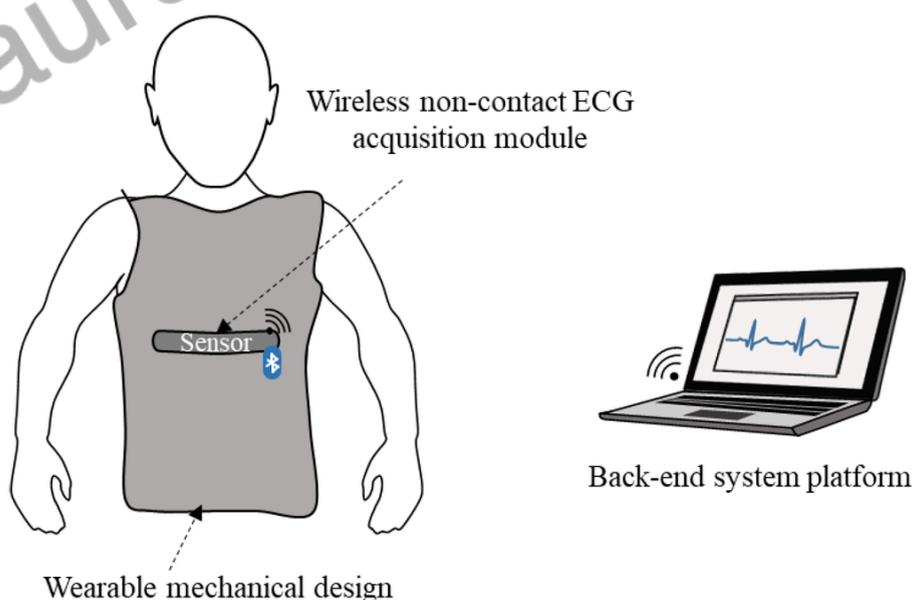
William Blake could have scarcely estimated just the expanse that a palm full can contain, when he said 'hold infinity in the palm of your hand', but science today can give him a fair estimate.

Smaller and smaller wearable devices, with the surface area the extent of a mere watch dial, have come to play, measuring all kinds of health parameters on the go - heart rate, blood oxygen, even continuous blood glucose levels. Here's yet another wearable, but one with a difference. Researchers have zeroed in on a wearable that can study the streams of molecular substances that pass through the skin, as a measure of studying the health status of individuals. What is different is that this wearable is 'non-contact' relying on an enclosed chamber immediately adjacent to the skin's surface to do its job.

A collaboration of American and South Korean experts from the domains of materials sciences, dermatology, engineering, bio-medical and chemistry



- **Non-contact wearable technology refers to sensors and devices that can monitor various parameters without direct skin contact.**
- **This technology uses techniques like radar, cameras, or other non-invasive methods to collect data, offering advantages like comfort, hygiene, and ease of use.**
- **Examples include non-contact temperature detectors, heart rate monitors, and activity trackers.**



□ **What is stratum corneum?**

The stratum corneum is the outermost layer of the skin, acting as a protective barrier.

It's a complex structure made of dead, flattened cells called corneocytes, embedded in a lipid matrix.

This layer is crucial for preventing water loss, protecting against external factors, and regulating cutaneous sensitization

Topic → Lawsonia inermis

saurabh pandey upsc



Deep marks: Many commercially available mehendi products are now mixed with additives and chemicals. FILE PHOTO

Dangers of adulterated henna

Monisha Madhumita

For centuries, mehendi, traditionally made from the crushed leaves of the *Lawsonia inermis* plant, has been an essential part of Indian celebrations, symbolising joy and auspicious beginnings at weddings and festivals. However, a growing body of reports about burns, allergic reactions, and even long-term skin damage after mehendi application has raised an important question: is all mehendi truly safe today?

To meet the rising demand for faster

- **Lawsonia inermis is a shrub that belongs to the family Lthyraceae and commonly known as henna.**
- **Paste of henna leaves contain two natural dyes, napthaquinone and lawsone, and are widely used for coloring of palm and hairs.**

Fact → To meet the rising demand for faster, darker stains, many commercially available mehendi products are now mixed with additives and chemicals.

One such chemical is para-phenylenediamine (PPD), a synthetic compound used to intensify and quicken colour development, producing a near-black stain within hours.



TOPIC --> 🍀 What are Private Members' Bills (PMBs)?

- **PMBs are legislative proposals introduced by non-minister MPs (i.e., private members), from both ruling and opposition parties.**
 - **Unlike government bills, PMBs reflect individual MPs' convictions, constituency interests, or emerging social needs.**
 - **Usually discussed on Fridays in Parliament sessions.**
-

Historical Context of PMBs |

| Since India gained independence, the significance of PMBs has evolved. Historically, only 14 PMBs have been passed and received presidential assent, with none clearing both Houses since 1970. This highlights a concerning trend where the potential of PMBs is not fully realized.

PMB Statistics from the 17th Lok Sabha |

| In the 17th Lok Sabha (2019-2024), a staggering 729 PMBs were introduced in the Lok Sabha and 705 in the Rajya Sabha. However, only a handful were ever discussed, with just two in the Lok Sabha and 14 in the Rajya Sabha making it to the discussion stage.

PMB Statistics from the 18th Lok Sabha |

| Fast forward to the 18th Lok Sabha, and the trend continues. Only 20 MPs have introduced PMBs so far, and during the inaugural and Budget Sessions of 2024, 64 PMBs were introduced in the Lok Sabha, yet not a single one was discussed. This raises questions about the effectiveness of PMBs in the current legislative environment.

Importance of PMBs |

|PMBs as a Platform for Individual MPs |

| PMBs serve as a vital platform for MPs to introduce legislation that resonates with their personal beliefs or the needs of their constituents. This is particularly important in a political landscape where party lines often dictate legislative priorities.

Challenges and Institutional Limitations

- **Anti-Defection Law (Tenth Schedule) restricts MP autonomy.**
- **Executive dominance over Parliament sidelines individual MPs.**
- **Lack of protected time for PMBs; procedural rigidity.**

Proposed Reforms for PMBs |

|Protecting PMB Time |

| To revitalize the PMB process, it's essential to treat the time allocated for PMBs as sacrosanct.

Amendments to parliamentary rules should ensure that this time is protected from being overridden, except in emergencies. |

Establishing a Review Committee |

| A dedicated review committee for PMBs could screen bills for quality and relevance, ensuring that

meaningful legislation is prioritized for discussion.

|

Extending Parliament Working Hours |

| Instead of encroaching on PMB time, Parliament could consider extending its working hours to accommodate more legislative business. This would enhance productivity and ensure that PMBs are not sidelined. |

Adopting the Ten-Minute Rule |

| Adopting a Ten-Minute Rule similar to that of the U.K. Parliament could allow MPs to introduce and discuss PMBs more efficiently, fostering a greater exchange of ideas. |

Conclusion |

| The role of PMBs in India's legislative landscape is crucial for fostering democracy and encouraging independent thought among MPs. By implementing necessary reforms, we can ensure that this mechanism is not only preserved but also strengthened, allowing for a more vibrant and responsive legislative process. |

Reviving a far-sighted but forgotten Bill mechanism

Priate Member's Bills (PMBs) are a mechanism through which Members of Parliament (MP), who are not Ministers, can propose their own legislation. In India's parliamentary system, most laws are introduced by the government, drafted by Ministries and tabled by Ministers. In contrast, PMBs come from individual MPs, both ruling party or the Opposition. In each session, Fridays are usually reserved for discussion on PMBs. PMBs are perhaps the last remaining intervention wherein MPs are not strictly guided by party mandate.

However, this crucial intervention has steadily eroded. Frequent disruptions, pre-emptive adjournments, and the increasing prioritisation of government business have reduced the PMB to a symbolic gesture rather than a serious legislative exercise. Ignoring the PMB is a procedural lapse and also signals a democratic backslide.

PMB trends, 17th and 18th Lok Sabha
Since Independence, only 14 PMBs have been passed and received presidential assent and none has cleared both Houses since 1970. In the 17th Lok Sabha (2019-24), 729 PMBs were introduced in the Lok Sabha and 705 in the Rajya Sabha. However, only two in the Lok Sabha and 14 in the Rajya Sabha were ever discussed.

In the 18th Lok Sabha, only 20 MPs have introduced PMBs so far. During the inaugural and Budget Sessions of 2024, 64 PMBs were introduced in the Lok Sabha, but not a single one was discussed.

In the winter session, two Fridays in the Lok Sabha were lost to disruptions, while another was taken up by a general discussion on the Constitution. Even in the Budget Session, the first Friday, usually reserved for private members, was used for discussions on the Union Budget. Only one Friday in the Lok Sabha saw any private member business-related activity, and even this was limited to a resolution. In the Rajya Sabha, out of 82 PMBs listed during the Budget Session, only 49 were introduced on a single Friday, and discussion began on just one, only to be cut short as the House was adjourned *sine die*.

PMBs have long provided a platform for MPs to introduce pieces of legislation that reflect personal convictions, constituency demands, or emerging social needs, regardless of party affiliation.

A notable example is the 'Right to Disconnect' Bill introduced by Supriya Sule of the Nationalist Congress Party, in the Lok Sabha on October 28, 2019. The Bill proposed granting employees the legal right to disengage from work-related



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The Private Member's Bill has the potential to be a gold mine for India's legislative landscape

communication beyond official working hours, addressing the increasing intrusion of work into personal life in the digital age. Though it did not proceed beyond the initial stage, the Bill sparked an important national conversation on mental health, work-life balance, and labour rights in a hyper-connected economy. It exemplifies how PMBs can be vehicles for forward-looking and unconventional ideas.

In contrast, some PMBs have had a more tangible legislative impact. In 2014, Tiruchi Siva of the Dravida Munnetra Kazhagam (Rajya Sabha), introduced the 'Rights of Transgender Persons Bill. On April 24, 2015, the Bill made history by becoming the first Private Member's Bill in over four decades to be passed by the Rajya Sabha. Though it did not clear the Lok Sabha, it laid the groundwork for the Transgender Persons (Protection of Rights) Act, 2019, introduced and passed by the government. This Bill is a powerful reminder of how private initiatives can shape the legislative agenda and compel government action on socially sensitive issues.

PMBs also offer space for MPs from the ruling party to express independent thought. Bharatiya Janata Party MP Gopal Chinayya Shetty's Bill calling for free medical and health-care facilities to the senior citizens in all Government and private hospitals is an example. His intervention demonstrates that even Treasury Bench MPs, often bound by government priorities, can use PMBs to introduce legislation based on personal insight or constituency feedback.

Shrinking space for independent action

One cannot overlook the institutional changes that have contributed to the reduced space for individual legislative initiative. The 52nd Constitutional Amendment, which introduced the Anti-Defection Law through the Tenth Schedule, aimed to ensure political stability. However, it has also had the unintended effect of limiting the ability of MPs, particularly the Treasury Benches, to independently question or deviate from their party's legislative agenda. In such a structured environment, the PMB remains one of the few avenues through which MPs across party lines can suggest constructive policy alternatives.

While voters in India may cast their ballots for candidates contesting on party symbols, their choices are often equally influenced by the individual's integrity, expertise and track record within the constituency. MPs are elected not solely to reiterate the party's position, but to serve as a voice for the aspirations and concerns of their constituents.

To safeguard the PMB process, a series of

procedural and structural reforms must be considered.

Reforms to pursue

The first is the need to treat the time earmarked for PMBs as sacrosanct. Amendments to the Rules of Procedure and Conduct of Business should explicitly protect this time from being overridden, except in cases of a national emergency. Dedicated hours for PMBs must not only be preserved but also enforced with consistency, enabling meaningful debate and potential adoption of the PMB.

Parliament could consider instituting a review committee specifically for PMBs, responsible for screening Bills for quality, relevance, and constitutionality. It could even recommend a priority list for discussion based on public importance and cross-party support. A fast-track mechanism may also be introduced for high-impact or broadly supported Bills to reach the floor in a time-bound manner.

In instances where the government feels constrained by time to transact its own legislative business, it should consider extending the overall working hours of Parliament, rather than encroaching upon the Fridays reserved for PMBs. The working hours in both Houses typically run from 11 a.m. to 4:30 p.m., which includes a lunch break. A modest extension, even by an hour or two, would significantly improve the productivity of Zero Hour and Question Hour, while ensuring that PMBs remain undisturbed. With the prospect of delimitation and a likely increase in the number of MPs in both Houses, the urgency of reform is greater than ever.

One compelling reform that could be adapted from international practice is the Ten-Minute Rule of the U.K. Parliament – any MP can make a short speech of up to 10 minutes in support of a PMB along with its introduction after which another MP may oppose it for an equal length of time. This allows Bills to be introduced, heard, and recorded without long time slots. Adopting a similar provision in the Indian context, either as an addition to or as a substitute for existing PMB procedures, could create a channel for a greater number of legislative ideas to enter the public domain.

The Vice President of India/Chairman of the Rajya Sabha, Jagdeep Dhankhar, has laid emphasis on the role of private member's business in deepening democracy. He described PMBs as "far-sighted, forward-looking, and a gold mine" for India's legislative landscape. These are words that reflect both the value and the potential of this mechanism when nurtured with sincerity.

GS Paper II – Federalism & Parliamentary Functioning

Q In a heavily executive-dominated legislature, how can mechanisms like Private Members' Bills be revitalised to reflect grassroots concerns and diverse policy ideas? Discuss.(250 Words)

TOPIC - NATURAL HYDROGEN (GS PAPER 3 ECONOMICS & ENVIRONMENT)

How can India tap its natural hydrogen potential?

What are some of the challenges to exploring and exploiting natural hydrogen resources? Is it a more expensive process than manufacturing hydrogen? How is the US going beyond just trying to locate and excavate natural hydrogen deposits? Does India have a growing hydrogen demand?

EXPLAINER

Kalyan Manjunathalli

The story so far: India, an economy in growth mode with aspirations for energy independence and a pledge to reach net-zero emissions by 2070, the exploitation and use of natural hydrogen offers a potentially game-changing opportunity. In an increasingly volatile world where national sovereignty, economic stability, and energy security become inseparable, tapping into this naturally occurring commodity could go a long way towards enhancing India's strategic autonomy.

How much potential does India have? India's hydrogen demand was projected to grow from six million tonnes per year this year to 2024 to over 50 Mt/year by 2070 to support its net-zero target. A preliminary study by some members of academia referencing model predictions of global geologic hydrogen reserves, arrived at a value of 2.75 million tonnes of natural hydrogen potential in India, if these estimates were to be true, we may not even need to engage in the process of manufacturing hydrogen anymore but rather pursue the quest of finding and producing naturally occurring hydrogen that would help decarbonise our economy faster at a lower cost.

On the heels of the recent findings of natural hydrogen reserves in the Andamans, stakeholders need to come up with directional estimates to bring attention of policy makers and investors to the overall potential of natural hydrogen in India. A comprehensive geological study is essential, considering critical factors such as the quality, extent, thickness, accessibility, and hydrocarbon generation potential of the source rock; presence and effectiveness of seals and traps; size and viability of hydrocarbon accumulations; potential losses during migration; and the accessibility of the



area for exploration and development.

What are the challenges? Natural hydrogen exploitation and exploration is no easy feat. It has technical, logistical, economic, and safety-related challenges. Accuracy

locating and quantifying underground hydrogen reserves is the primary challenge. Unlike oil and gas, for which well-established exploration techniques exist, natural hydrogen exploration is still evolving. Additionally, efficient and cost-effective extraction technology for natural hydrogen is key. While modifying current gas industry practices associated with well drilling and extraction facilities, one must consider hydrogen's specific properties, including its small molecular size and high diffusivity. Studies into extraction solutions for lowest cost

hydrogen are in progress.

Hydrogen extraction also involves specific safety issues as opposed to hydrocarbon because of its high diffusivity and reactivity. Mitigation measures involve the study and application of hydrogen-resistant materials such as metal coatings and advanced alloys, cement additives to make it more resistant to hydrogen, and rubber liners to avoid degradation.

How can India kickstart the process? A key component of the Indian Solar PV mission's growth was the German Agency for International Cooperation/National Institute of Wind Energy funded Solar Radiation Resource Assessment (SIRA) Project under the National Solar Mission that commissioned 12 SIRA stations along with four Advanced Monitoring

Stations (AMS). Natural hydrogen agencies can formulate a similar public-private partnership to assist in the identification of potential geophysical deposits.

The U.S. ABB's E's newly funded projects take exploring the potential of geologic hydrogen beyond locating and extracting to explore geologic hydrogen towards the possibility that hydrogen can be produced intentionally, by drilling and flowing water into rock and then transferring the hydrogen to the surface for collection. Another approach involves injecting water with dissolved carbon dioxide into iron-containing rocks that could potentially lead to carbon sequestration as limestone while simultaneously producing hydrogen.

The Oil and Gas Exploration Industry in India, with the help of the Directorate General of Hydrocarbons, could review the rock samples available with them and explore more wells across the country with adequate grant and debt capital. A few of the current natural gas pipelines could be suitable for transferring hydrogen with adequate modifications and safety studies. Creating low-cost and safe solutions for hydrogen storage, especially massive underground storage, is imperative.

Even as estimates indicate natural hydrogen production would be much lower in cost than produced hydrogen, the actual cost of exploration, extraction, and infrastructure investment must be weighed seriously. Commercial feasibility will rely on finding large and accessible reserves and minimising extraction and delivery costs. Targeted exploration in areas of high potential, cost-reducing, extraction technology development, and institution of transparent regulatory systems are essential to spur investment and market growth.

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THE GIST

India's hydrogen demand was projected to grow from six million tonnes per year this year to 2024 to over 50 Mt/year by 2070 to support its net-zero target.

Natural hydrogen exploitation and exploration is no easy feat. It has technical, logistical, economic, and safety-related challenges.

The U.S. ABB's E's newly funded projects take exploring the potential of geologic hydrogen beyond locating and extracting to explore geologic hydrogen towards the possibility that hydrogen can be produced intentionally.



Why Natural Hydrogen Matters

- India, as a growing economy aiming for **net-zero emissions by 2070**, needs cleaner, scalable energy sources.
- **Natural (geologic) hydrogen**—hydrogen that occurs naturally in underground rock formations—offers a **low-cost, low-emission alternative** to industrial hydrogen production.
- Recent discoveries (e.g., in the **Andaman and Nicobar Islands**) have sparked interest in exploring this untapped resource.
- **Current and Future Demand Projections**
 - India's hydrogen demand is projected to skyrocket from six million tonnes per year (Mt/year) in 2020 to over 50 Mt/year by 2070. This surge is essential to support the country's net-zero target, making the

exploration of natural hydrogen not just beneficial but necessary.

□ **The Potential Reserves in India**

- A preliminary study suggests that India could have up to 3,475 million tonnes of natural hydrogen potential. If these estimates hold true, India might not need to manufacture hydrogen but could focus on discovering and producing this naturally occurring resource, accelerating the decarbonization process at a lower cost.

□ **Challenges in Exploration & Extraction**

□ **Technical**

- Lack of established exploration techniques (unlike oil & gas).
- Difficulty in **locating and quantifying** underground hydrogen.
- Need for **specialized drilling and extraction technology** due to hydrogen's small molecular size and high diffusivity.

□ **Safety**

- Hydrogen is **highly reactive** and prone to leakage.
- Requires new **hydrogen-resistant materials** (e.g., coatings, alloys, cement additives).

□ **Economic**

-
- Cost of exploration, infrastructure, and safety compliance could be high.
 - Commercial viability depends on **size**, **accessibility**, and **cost-effectiveness** of reserves.

□ **Strategies to Kickstart Natural Hydrogen Exploration**

□ **Learning from Global Initiatives**

India can take cues from successful global initiatives. For instance, the U.S. ARPA-E has funded projects that explore innovative methods for hydrogen production, such as drilling water into rock formations to extract hydrogen. These approaches could inspire similar projects in India.

□ **Public-Private Partnerships**

A public-private partnership could be instrumental in identifying potential geographical deposits of natural hydrogen. Just as the Indian Solar PV mission benefited from collaboration, a similar model could accelerate natural hydrogen exploration.

□ **The Role of the Oil and Gas Industry**

□ **Reviewing Existing Infrastructure**

The Oil and Gas Exploration industry in India, with the Directorate General of Hydrocarbons' support, can

review existing rock samples and explore new wells. Some current natural gas pipelines may be suitable for transporting hydrogen with necessary modifications.

□ **Innovations in Extraction Technology**

Developing cost-effective extraction technologies is crucial. Research into low-cost hydrogen extraction solutions is ongoing, and innovations in this area could significantly reduce the costs associated with natural hydrogen production.

Conclusion: The Path Forward for India

The potential of natural hydrogen in India is immense, but realizing this potential requires overcoming significant challenges. By fostering public-private partnerships, leveraging existing infrastructure, and investing in innovative technologies, India can position itself as a leader in the natural hydrogen sector. The journey toward energy independence and a sustainable future is within reach, and natural hydrogen could be the key to unlocking that future

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Q Hydrogen is considered a future fuel, yet its extraction and storage pose unique technological and safety challenges.

Critically analyse India's preparedness to explore and exploit natural hydrogen.(250 WORDS)

Can the Indus Waters Treaty be suspended unilaterally?

What does the Vienna Convention on the Law of Treaties stipulate with respect to suspending or terminating treaties between countries? How will a disruption in water flow affect Pakistan?

Aaratrika Bhaumik

The story so far:

The 1960 Indus Waters Treaty (IWT) gives India unrestricted rights over the three eastern rivers – Ravi, Beas, and Sutlej. While Pakistan was given exclusive control over the three western rivers – Indus, Jhelum, and Chenab, India retained limited rights to use the waters for “non-consumptive” purposes. However, following the terror attack in Pahalgam on April 22, India announced the IWT would be held in abeyance with “immediate effect”.

Is unilateral suspension permissible? The IWT cannot be altered unilaterally. Article XII stipulates that the treaty can only be terminated through a “duly ratified treaty” agreed upon by both states. The term “hold in abeyance,” as

used by India in its letter to Pakistan, is neither recognised in international law nor mentioned in the Vienna Convention on the Law of Treaties (VCLT), 1969, the principal treaty governing agreements between states. “The VCLT does not use the word ‘abeyance’; it uses the term ‘suspension,’ which allows a country to suspend the operation of an entire treaty or a part of it. Suspension is distinct from termination. I believe that when India used the word ‘abeyance,’ it intended to mean ‘suspension’ rather than termination of the IWT,” Dr. Prabhakar Ranjan, professor at Jindal Global Law School, told *The Hindu*.

Article 62 of the VCLT allows a treaty to be repudiated if there has been a “fundamental change of circumstances” from those existing at the time of its conclusion. Although India is not a party to the VCLT and Pakistan has signed but not ratified it, the International Court of

Justice (ICJ) in the *Fisheries Jurisdiction* cases affirmed that Article 62 codifies customary international law and is therefore binding regardless of formal ratification. India appears to be invoking this principle, as its letter stated that “fundamental changes in the circumstances” require a “reassessment of obligations” under the IWT. However, Dr. Ranjan pointed out that ICJ rulings have set a high threshold for what qualifies as a “fundamental change in circumstances”. In the 1997 *Gabcikovo-Nagymaros Project* dispute between Hungary and Slovakia over the construction of a dam, Hungary argued that political and economic shifts, along with the threat of environmental disaster, provided sufficient grounds to terminate the treaty. However, the ICJ rejected these arguments, noting that the political and economic changes were not directly linked to the treaty’s primary objective –

joint energy production.

How will this affect Pakistan?

More than 80% of Pakistan’s agriculture and around a third of its hydropower generation depend on the waters of the Indus basin. However, experts say that India lacks the massive storage infrastructure and extensive canal systems needed to withhold tens of billions of cubic metres of water from the western rivers. “The infrastructure India possesses consists largely of run-of-the-river hydropower plants, which do not have the capacity for large-scale storage. However, the real impact lies in the uncertainty over water flow, which could severely affect Pakistan’s predominantly agrarian economy. If India begins regulating the flow using its existing infrastructure, Pakistan could experience significant disruptions,” Dr. Happyman Jacob, associate professor at the School of International Studies, JNU, told *The Hindu*. A senior government official earlier told *The Hindu* that India will explore “options that it has never considered” under the IWT, such as redesigning its hydroelectric projects to increase water storage capacity and deploying ‘drawdown flushing’ of its reservoirs. The abrupt release of large volumes of water without prior warning could potentially cause significant damage downstream in Pakistan.

THE GIST

▼ The 1960 Indus Waters Treaty (IWT) gives India unrestricted rights over the three eastern rivers – Ravi, Beas, and Sutlej.

▼ The IWT cannot be altered unilaterally. Article XII stipulates that the treaty can only be terminated through a “duly ratified treaty” agreed upon by both states.

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