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1. Virtual Magnet Claims Reveal Why EVs Need Their Rare Earths
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‘Virtual magnet’ claims reveal why EVs need their rare-earths

A large amount of effort has gone towards replacing permanent magnets in the rotor with either electromagnets or just a piece of iron; however, efficiency, starting torque capability, and the maximum speed achievable are some important constraints that have kept such motors out of EVs

G. Bhuvaneswari

In any EV, the battery pack is the costliest and heaviest component, which is why the focus is on optimising the battery’s rating. In turn, permanent magnet synchronous motors dominate the EV market because their efficiency is the highest at present. J. ALLEN EGENUSE

There have been a number of news reports recently about a startup in Bengaluru called Vimag Labs that has replaced rare-earth magnets in motors with so-called “virtual” magnets.

One such report quoted Manish Seth, the start-up’s CEO, as saying: “We remove permanent magnets, replace them with copper coils, and then through software, we generate magnetic fields inside the motor.”

To understand this claim, it helps to first see how electric motors produce magnetic fields and why they use permanent magnets in the first place.

Rotor and stator

A motor needs a magnetic field to operate. One way to create it is using a permanent magnet. Another is to pass current through copper coils that have been wound around a ferromagnet, temporarily turning it into a magnet. This is called an electromagnet – and it is this approach that the startup has used, instead of permanent magnets.

When an electrical machine converts electricity into mechanical motion, it is called a motor. On the other hand, a machine that converts mechanical movement into electricity is called a generator. In both cases, the conversion happens via a magnetic field.

In a motor, for example, mechanical energy is harvested when the electric energy is used to rotate a component called the rotor. In a generator, electricity is harvested through conductors embedded in a stationary component called the stator.

You can imagine both the stator and the rotor to be two concentric cylinders. Most of the time, the rotor is the inner cylinder. And the magnetic field is established in the gap between the stator and the rotor for the energy conversion process to happen.

An old technology

This is how the large generators in hydroelectric, thermal, and nuclear power plants work. And for a long time now, they have used electromagnets instead of permanent magnets.

In these generators, a turbine spins the rotor. In a thermal or nuclear power station, the turbine is driven by steam. In a hydroelectric power station, it is driven by falling water. The rotor rotates at a fixed speed to generate an alternating current (AC) of frequency 50 Hz. The rotor has copper coils wound around its ferromagnetic core. When these coils are supplied with a direct current (DC), they create a magnetic field, and the core acquires a magnetic north and a magnetic south pole. And as the rotor spins, this magnetic field sweeps past the stator windings, inducing an alternating voltage in them. This helps convert mechanical power into electricity. This technology has been around for 135 years.

The next question is how electricity can be fed continuously into coils that are themselves rotating. Enter: the brushless excitation system. The rotor coils need DC – but supplying it through sliding electrical contacts is difficult because the rotor is constantly spinning. The solution is to mount a rectifier, a device that converts AC into DC, on the rotor itself. To this rotating rectifier, an AC is supplied from another generator. And this other generator is coupled to the same shaft of the turbine imparting mechanical power to the main generator.

Software and magnetism

This is essentially the principle behind the start-up’s “virtual” magnet: software regulates the current flowing through the electromagnets, thus controlling the strength and direction of the magnetic field. The rectified current can be fed in a controlled manner to the copper coils in the rotor that would make the magnetic strength and direction controllable.

In other words, the software is not creating magnetism by itself. It is just controlling how much current flows through the electromagnets, and thus how strong the magnetic field becomes. There is no novelty in this design.

A permanent magnet establishes the magnetic field in the air gap of an electrical machine in a one-step process. And because the magnet already exists, no electrical energy is needed simply to create the magnetic field. On the other hand, with electromagnets, the magnetic field first has to be established, and the electric current modulated as per the requirement using software.

And every additional step here consumes some energy. There are magnetic losses in the ferromagnetic core, called core losses. The copper conductor has resistance losses. The electronic switches have switching and conduction losses. As a result, it is unlikely for a motor with an electromagnet to be more efficient than a motor with a permanent magnet.

Electromagnets in EVs

BMW and Renault have been trying to build such an electrically excited motor. The three-phase induction motor that Nikola Tesla invented in 1888 – a light yet rugged machine – was used by the first version of the Model S from Tesla in 2012. However, its efficiency was not good enough.

Every 0.1% increase in efficiency of the propulsion motor drive matters in an electric vehicle (EV). This is because any increase in the drive’s efficiency will improve the range drastically for a given battery rating. Put another way, for a given mileage, the battery size can be reduced when the efficiency of the motor drive improves. Thus, increasing the motor drive’s efficiency will bring down the weight and cost of the car perceptibly.

In any EV, the battery pack is the costliest and heaviest component, which is why the focus is on optimising the battery’s rating. In turn, permanent magnet synchronous motors dominate the EV market because their efficiency is the highest at present.

Electromagnets are not the only alternative to permanent magnets. Another approach is the switched reluctance motor (SRM), whose rotor contains neither permanent magnets nor copper coils. Instead, SRMs have lower rotor inertia than even induction motors. In exchange, their torque comes in spurts, which makes the motor noisy and less efficient.

Recently, Honda joined hands with a start-up from Canada called Enedym to improve the performance of an SRM to be used in an EV. Hitachi Astemo is similarly trying to use a synchronous reluctance motor in a battery-driven EV to get rid of the dependency on rare-earth magnets.

On the whole, a large amount of effort has gone towards replacing permanent magnets in the rotor with either electromagnets or just a piece of iron. However, efficiency, starting torque capability, and the maximum speed achievable are some important constraints that have kept these motors out of EVs.

At this time, we will have to wait and see how the Bengaluru start-up fares in the four-wheeler EV market.

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Which of the following statements about Rare Earth Elements (REEs) and Critical Minerals is/are correct ?

1. Modern technological innovations including Artificial Intelligence, robotics and space exploration extensively utilise Rare Earth Elements (REEs).

2. China has the highest share in mining of REEs followed by India.

3. The Government of India launched the National Critical Mineral Mission (NCMM) in 2025 to establish a robust framework for self-reliance in the critical mineral sector.

4. Rare Earth Elements are a set of 13 metallic elements.

Select the answer using the code given below :

(a) 1 and 3 only

(b) 3 only

(c) 1, 3 and 4

(d) 1, 2 and 4

Context (GS-III: Science & Technology – Electric Vehicles, Critical Minerals)

A Bengaluru-based startup, Vaying Labs, has claimed to develop a **'virtual magnet'** technology that replaces rare-earth permanent magnets in EV motors with software-controlled electromagnets. The innovation aims to reduce dependence on rare-earth minerals without compromising motor performance.

Key Points

I. What is a Virtual Magnet?

* It is not a physical magnet but a magnetic field created by software-controlled electromagnets.
* Software regulates the current through copper coils to mimic the behaviour of a permanent magnet.

II. Why is it important?

* EV motors currently rely on rare-earth permanent magnets, making them dependent on a limited global supply of critical minerals.
* Virtual magnets seek to reduce this dependency and improve supply-chain security.

III. Why are permanent magnets still preferred?

* They generate magnetic fields without continuous electricity.
* Hence, they offer higher efficiency, better torque and longer driving range, making them the dominant choice in EVs.

IV. Limitation

* Electromagnets consume electricity continuously, resulting in energy losses.
* Therefore, virtual magnet technology is yet to match the efficiency of permanent-magnet motors.

Prelims Pointer

* **Rare Earth Elements (REEs):**
    * A group of 17 metallic elements comprising 15 lanthanides + Scandium + Yttrium.
    * They are not actually rare, but economically exploitable deposits are scarce.
    * Used in EV motors, wind turbines, electronics, defence systems and permanent magnets.
    * Neodymium (Nd), Praseodymium (Pr) and Dysprosium (Dy) are the most important REEs used in high-performance EV motors.

FCRA Bill 2026, a threat to civil society organisations

P.D.T. Achary

Former Secretary General, Lok Sabha

According to the government's legislative programme for the monsoon session of Parliament, the Foreign Contribution (Regulation) Amendment Bill, 2026, has been listed for consideration. Although the Bill was included in the legislative agenda during the previous session, its consideration was postponed following widespread protests, particularly from Christian organisations and non-governmental organisations (NGO). At the time, the government made it clear that it remained committed to passing the Bill. Nevertheless, some interpreted the postponement as a sign that the government intended to defer it indefinitely or even drop it altogether. Those expectations have now been dispelled.

The politics of foreign contributions

In India, foreign contribution has always been a controversial issue. Normally, foreign contributions are allowed to support humanitarian relief and sectors such as health care, education, and environmental protection.

However, the inflow of foreign funds is regulated in all countries that permit such contributions. In India, there was no statutory framework governing foreign contributions before 1976, when the government of Indira Gandhi enacted the Foreign Contribution (Regulation) Act (FCRA) for the first time. The Act established a regulatory framework to control the acceptance and utilisation of foreign contributions and foreign hospitality. In fact, the government of the day feared, whether real or perceived, the destabilisation of India's democratic system by foreign forces inimical to India's interests. The Emergency regime was quite paranoid about the inflow of foreign money through multiple channels, including NGOs operating in the country.

The most interesting aspect of the brouhaha often raised over foreign contributions in India is that such contributions were never prohibited in general; they were always permitted to come into India. Of course, their acceptance and utilisation came under regulation, which became progressively stricter with every amendment. In 2010, the existing law was replaced by the Foreign Contribution (Regulation) Act, 2010. As in the 1976 Act, the primary focus of regulation under the 2010 Act was the legislature and political parties. The government's concern was the possibility of a large-scale infusion of foreign money into politics. This concern was adequately addressed in the 2010 Act, wherein provisions were made to prohibit the receipt of any form of foreign contribution by candidates for election, media personnel, public servants, judges, government employees, members of the legislature, political parties and their office-bearers, as well as organisations of a political nature.

The Act also provided for the vesting of assets created out of foreign contributions in a prescribed authority under certain circumstances and situations. It was also laid down that any person or organisation engaged in definite cultural, economic, educational, religious, or social programmes must obtain a certificate of registration, without which no foreign contribution could be received. One point that deserves mention in the context of these laws is that, although they were regulatory in nature, they were not unduly harsh on the recipients. Foreign funds were allowed to flow into the country for a variety of humanitarian purposes, under the prescribed regulatory framework.

The Foreign Contribution (Regulation) Amendment Bill, 2026 expands state control over NGOs and civil society

Sledgehammer effect

But when we look at the present Bill, it gives us a different picture. It in fact has a sledgehammer effect on NGOs and religious and cultural organisations.

The Act of 2010 contains provisions for the registration of applicants and the grant of certificates to receive foreign contributions. There are different conditions under which such a certificate is issued. One of these conditions is that the applicant has not been prosecuted, convicted, or found to have indulged in activities aimed at religious conversion through inducement or force, either directly or indirectly, from one faith to another. Another condition is that the applicant has not been prosecuted or convicted for creating communal tension, disharmony, or similar disturbances. Under the Bill of 2026, if such a certificate is cancelled, the foreign contribution received by the applicant, along with all assets created out of that foreign contribution, shall vest in a designated authority.

Section 16A(2) makes it clear that even if an asset has been created only partly out of foreign contributions, the whole asset shall vest in the designated authority. Initially, such vesting shall be provisional. However, if the applicant fails to obtain a fresh certificate or to have the certificate renewed or restored within the prescribed time frame, the foreign contribution and the assets created from it shall vest permanently in the designated authority. The authority may then transfer such assets to any ministry, department, or agency of the central government, a State government, or a local authority. It may also dispose of the assets through sale, auction, or any other prescribed method, and credit the sale proceeds, together with any unutilised foreign contribution, to the Consolidated Fund of India.

Thus, the cancellation of a certificate becomes a crucial factor in completely ruining an organisation that functions primarily on the strength of foreign contributions. It is, therefore, instructive to examine the circumstances under which a certificate authorising the receipt of foreign contributions can be cancelled by the government.

Clause (1)(c) of Section 14 of the Foreign Contribution (Regulation) Act, 2010, provides that a certificate may be cancelled if, in the opinion of the central government, it is necessary, in the public interest, to do so. The consequence of such cancellation is that the organisation loses its authority to receive foreign contributions, its assets created out of such contributions may be taken over, and its activities may effectively come to a halt. This provision confers unfettered powers on the government to cancel a certificate at any time. The term "public interest" is vague. As the government is the custodian of public interest, it can readily justify its actions on that ground. Cancellation of the certificate would result in the vesting of the foreign contribution and the assets created out of it in the designated authority. Depending on the nature of the organisation, such assets could even include places of worship.

Cancellation of a certificate may also result if an individual or organisation is prosecuted in connection with a case alleging religious conversion through force or inducement. Experience suggests that it is very easy for a person determined to have the certificate of a religious organisation cancelled to file a complaint in a police station or in a court alleging forcible religious conversion. Consequently, this provision has immense potential for misuse, particularly against minority religious groups.

A rather unusual provision in this Bill is that if a person surrenders a certificate of registration, the entire foreign contribution remaining with the person, along with all the assets created out of such contribution, will vest in the designated authority. It is difficult to understand the rationale behind this provision. A person or organisation that has availed of foreign contributions and created assets from them may, after some time, decide that it no longer requires any further foreign contributions and may therefore surrender its certificate. However, under Clause 16A(1)(b) of the Bill, all the assets created out of the foreign contribution, together with any unutilised portion of such contribution, shall vest in the authority.

Exemption clause

Finally, Clause 16L exempts any organisation, class of organisations, or person from the operation of this Bill if the government considers such an exemption to be in the public interest. Although the purpose of this clause appears to be obvious, the concern is that it may be vulnerable to challenge under Article 14 of the Constitution, which guarantees equality before the law. The clause neither identifies any intelligible differentia that distinguishes the favoured class of organisations or persons from those to whom the law applies in its entirety, nor establishes a rational nexus between such differential treatment and the object sought to be achieved by the legislation. The exemption of individuals or organisations is left entirely to the government's opinion that such action is expedient in the public interest. It is clear from the overall scheme of these amendments that the state seeks to eliminate organisations active in the educational, cultural, environmental, and charitable sectors on account of certain deep-seated prejudices.

8. Examine critically the recent changes in the rule governing foreign funding of NGOs under the Foreign Contribution (Regulation) Act (FCRA), 1976.

Context (GS-II: Polity & Governance – NGOs, FCRA, Civil Society)

The Foreign Contribution (Regulation) Amendment Bill, 2026 has been listed for consideration in Parliament. The Bill seeks to amend the FCRA, 2010 by expanding the government's powers over NGOs receiving foreign funds, raising concerns over the autonomy of civil society organisations.

Key Points

I. Why was FCRA enacted?

* To regulate the acceptance and utilisation of foreign contributions so that they do not adversely affect India's sovereignty, integrity, security, public interest or democratic processes.
* India first enacted the FCRA in 1976, which was replaced by the FCRA, 2010.

II. FCRA, 2010 – Basics

* Administered by the Ministry of Home Affairs (MHA).
* Mandatory registration or prior permission is required to receive foreign contributions.
* Registration is generally valid for five years and requires renewal.
* Prohibits foreign contributions to election candidates, legislators, political parties, judges, government servants and certain other public functionaries.
* Provides for suspension or cancellation of registration in specified circumstances.

III. Major Changes Proposed in the FCRA (Amendment) Bill, 2026

* Assets created from foreign contributions will vest in a designated government authority if an organisation's registration is cancelled, expires, is not renewed or is voluntarily surrendered.
* Expands the government's power to cancel registration in the "public interest", without clearly defining the term.
* Empowers the government to exempt any individual or organisation from the Act if considered in the public interest.

IV. Concerns

* Enhances executive discretion over NGOs and civil society organisations.
* The undefined expression "public interest" may allow arbitrary cancellation of registration.
* Vesting of NGO assets in the government may discourage charitable and humanitarian activities.
* The exemption clause may be challenged under Article 14 for lacking clear and objective criteria.
* May have a disproportionate impact on NGOs working in education, health, environment, religion and social welfare.

Behind China's AI gift, a constraint

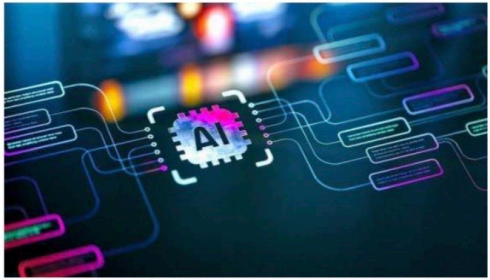
China's embrace of open-weight AI models is driven as much by compute constraints as by a bid to project itself as a responsible global AI power; until it overcomes chip and inference bottlenecks, Beijing is likely to keep sharing its models with the world

WORLD INSIGHT

Amit Kumar

At the ninth World AI Conference in Shanghai this month, Chinese President Xi Jinping addressed the gathering for the first time in nine years. It is indicative of the priority that AI occupies for the leadership. At the conference, Mr. Xi pitched Chinese AI models as a global public good. The contrast was clear as day. America is selling closed-source, proprietary models while China is offering open-weight models to the world. This distinction is not merely technical, but equally political.

Unlike Anthropic, OpenAI, and Google, which host their frontier models on their respective servers and offer services via an application programming interface (API), Chinese labs such as DeepSeek, Qwen, and Moonshot also release their weights for anyone to download. Unlike American models, these can be customised, modified, and even further trained. There is no subscription to cancel or terms of service. The maker cannot revoke or restrict access. So long as one can manage the requisite compute to host the model, even Papua New Guinea or Senegal can run it locally on their servers. And most importantly, the data never leaves the border.



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AI diplomacy

However, one may wonder what explains China's benevolence. Well, to begin with, the objective is to project China as a responsible AI player in the comity of nations. Unlike the Americans, who he alleged to have overstretched the concept of national security to AI, and thereby adopted an exclusionary approach, China is committed to sharing the benefits and fruits of AI. Mr. Xi's framing was indicative in this regard. He described AI as "humanity's collective wisdom," a "historic opportunity" to "bridge the AI and digital divides," and something that "should not be a solo performance by a single country but a symphony of international cooperation." The underlying message, aimed at Washington, projected Beijing as the open and cooperative alternative to the U.S.'s AI models.

But there is a limiting factor at play too that explains Beijing's benevolence – its compute constraint, both for training and inference.

Since 2022, the U.S. administration, in concert with its allies, has imposed a series of export restrictions on China, limiting its ability to both mass-import and mass-manufacture high-end chips.

The compute constraint

To understand this constraint, one must separate two very different tasks – training a model and serving it. Training is a one-time cost. A lab assembles a cluster of chips, runs it for a few months and comes up with a finished model. The fleet required is numerically small. For instance, GPT-4 was trained on an estimated 25,000 Nvidia chips, and Meta trained its Llama 3.1 on ~16,400 chips. DeepSeek, on the other hand, trained its acclaimed V3 model on ~2,000 export-compliant H800s. A frontier model, in other words, needs chips in the thousands, and it needs them only once.

Serving that model to the public, however, is an altogether different proposition. Inference scales with the user base and requires continuous expansion as it must answer hundreds of millions of user queries. OpenAI crossed a million GPUs in 2025, and Meta targeted the equivalent of 1.3 million by the end of 2025. Thus, for any model with a mass consumer base, the serving fleet dwarfs the training fleet, often by ten to a hundred times.

In other words, the distinction is that of a stockpile and a flow. To train a model, a lab can accumulate ten or twenty thousand chips through smuggling, stockpiling, and modest domestic production. This is precisely why the export controls could not prevent China from reaching parity at the model level. Inference, however, cannot be solved this way. The export controls mean that the most advanced chips remain out of bounds for Chinese firms. Additionally, the concessions the U.S. has offered exist largely on paper. Around 10 Chinese firms were cleared in principle to buy up to 75,000 H200 chips each, but not a single unit had been delivered by mid-2026, as sales remained stalled and Beijing itself directed firms towards domestic alternatives.

China can attempt to bridge the shortfall through domestic production, but even here, restrictions on export of EUVs continue to prove a handicap. SMIC's 5nm line in China runs at roughly 20% yield without EUV tools, far short of commercial viability. This severely restricts the ability of Chinese labs to offer services via API alone. DeepSeek's decision to freeze new registrations in January 2025 was influenced by a surge in traffic it could not serve, alongside a reported 'large-scale malicious attack'.

Openness by necessity

Furthermore, given that Chinese models are nearly as good as the U.S.'s frontier models, their popularity is increasing. Data show that the Chinese models' share of U.S. firms' AI usage has hit a record 60% on OpenRouter – a marketplace for routing queries to various models based on requests.

American firms are preferring Chinese models as they provide comparable services at a fraction of the cost. But this success comes with a rider – the need for enormous compute. The solution thus is to simply outsource compute via open-weight models. Hence, China's open-weight offering to the world is largely a product of its structural constraint. It can build models that rival the U.S. but cannot serve them at scale.

But Beijing cannot ignore the urge to securitise and restrain access for too long. Sooner or later, it will face that choice. Indeed, Beijing is already reported to be weighing restrictions on overseas access to its most capable models.

One can expect China's frontier models to move towards proprietary models, while trailing models remaining open-weight. But so long as China cannot overcome the larger constraint, it is likely to continue fielding open-weight models. And China's constraint is the world's gain.

(Amit Kumar is a Staff Research Analyst at Takshashila Institution)

THE GIST

- China's open-weight AI models can be downloaded, customised and deployed on local servers, allowing countries to retain control over their data without relying on proprietary, API-based services.
- Even as Beijing promotes open-weight AI as a global public good, it is already weighing restrictions on overseas access to its most capable frontier models, signalling that this openness may not be permanent.

Context (GS-III: Science & Technology – Artificial Intelligence, Semiconductor Technology) | GS-II: International Relations – India-China, Technology & Geopolitics

China is increasingly releasing **open-weight AI models** (such as DeepSeek and Qwen), presenting itself as a champion of open AI. However, the article argues that this strategy is driven not only by AI diplomacy but also by U.S. chip export restrictions and China's limited computing capacity.

Key Points

I. What are Open-weight AI Models?

* The model's trained weights are publicly available, allowing users to download, modify and deploy them on their own servers.
* Unlike closed AI models (e.g., OpenAI, Anthropic), users retain greater control over their data and customization.

II. Why is China promoting them?

* China projects itself as a responsible global AI power by promoting AI as a global public good.
* Open-weight models help expand China's technological influence and build an international AI ecosystem.

III. The Real Constraint

* China's AI strategy is also shaped by U.S. restrictions on advanced AI chips and semiconductor manufacturing equipment.
* While China can train competitive AI models, it lacks sufficient high-end computing infrastructure to serve millions of users efficiently (AI inference).
* Therefore, distributing open-weight models shifts the computing burden to users instead of Chinese companies.

Private R&D spends cross govt.'s in FY24

A level last seen in 2009-10, official data reveal a structural shift: private industry accounted for 45.5% of national R&D spending in 2021-22, rising further to 51.8% in 2023-24, the first time businesses have contributed more to India's research effort than all levels of government combined

Jacob P Koshy
NEW DELHI

India's spending on research and development (R&D) surged to 0.83% of GDP in 2021-22, the first time that the country crossed the 0.8% threshold – a level last seen in 2009-10, according to newly disclosed government data.

The figures also reveal a structural shift in India's innovation landscape: private industry accounted for 45.5% of national R&D spending in 2021-22, rising further to 51.8% in 2023-24, the first time businesses have contributed more to India's research effort than all levels of government combined.

The figures were disclosed by the Department of Science and Technology (DST) in response to a Lok Sabha questionon Wednesday. They form part of the latest Research & Development Statistics 2025-26, although the full statistical report itself has not yet been publicly released.

The numbers are significant because India, despite possessing one of the world's largest scientific workforces and ranking among the top countries in scientific publications, has long spent a much smaller share of its economy on research than major scientific powers. The share of R&D in GDP - long considered a bellwether of progress - has, in the case of India, steadily fallen every year till it reached its nadir of 0.64% in 2020-21.

That year China spent 2.4% of GDP, Japan 3.3%, South Korea 4.8%, United States 3.5% and around 5% in Israel. Successive governments have also repeatedly argued that India's innovation ecosystem is constrained because industry contributes a much smaller share of national R&D spending than in advanced economies, where business routinely accounts for over 70% of research expenditure.

Science wins

The numbers are significant because India has long spent a much smaller share of its economy on research than major scientific powers

- India's share of R&D in GDP has steadily fallen every year till it reached its nadir of 0.64% in 2020-21
- That year, China spent 2.4% of GDP, Japan 3.3%, South Korea 4.8%, U.S. 3.5%, Israel 5%

DST compiles India's official R&D statistics through its National Science and Technology Management Information System (NSTMIS), which has conducted national science surveys since 1973 using UNESCO and OECD definitions. The surveys gather expenditure data from central and state government agencies, universities, public sector enterprises and private industry. The 2022-23 edition explicitly stated that its coverage had been expanded to include multinational companies and enterprises outside the Department of Scientific and Industrial Research's recognition scheme. There were 2,397 DSIR-recognised in-house R&D centres as of December 2022. Until Wednesday's parliamentary reply, the latest publicly available DST publication was the 2022-23 edition, released in 2023, which contained data only up to 2020-21. The parliamentary reply is therefore the first official disclosure of India's R&D expenditure for 2021-22, 2022-23 and 2023-24, even though the corresponding statistical reports have yet to be published.

The fresh data point to an abrupt discontinuity. Gross Expenditure on Research and Development (GERD) fell from ₹1.33 lakh crore in 2019-20 to ₹1.27 lakh crore in 2020-21 (a COVID-year slump), before jumping 53% to ₹1.95 lakh crore in 2021-22. It subsequently rose to ₹2.13 lakh crore in 2022-23 and ₹2.45 lakh crore in 2023-24.

However, budget documents from the period do not suggest a commensurate surge in government science spending. Union allocations to the Department of Science and Technology, Department of Biotechnology, Department of Atomic Energy, ISRO and other major science agencies rose only incrementally across these years, making it unlikely that the increase was driven solely by public expenditure.

The sharp rise in GERD coincided with a dramatic increase in the private sector industry's contribution to India's research spending. Private industry accounted for 38.5% of GERD in 2017-18, 37.7% in 2018-19, 33.8% in 2019-20 and 36.4% in 2020-21, before jumping to 45.5% in 2021-22, 48.0% in 2022-23 and 51.8% in 2023-24 – the first time private industry has contributed more than half of India's total R&D expenditure. In absolute terms, Industry R&D spending increased from about ₹43,800 crore in 2017-18 and ₹46,700 crore in 2018-19 to ₹44,800 crore in 2019-20 and ₹46,400 crore in 2020-21, before almost doubling to ₹88,600 crore in 2021-22 and rising further to ₹126,800 crore in 2023-24.

Context (GS-III: Science & Technology – Research & Development, Innovation Ecosystem)

Government data released by the Department of Science & Technology (DST) shows that private industry contributed more than the combined government sector to India's R&D expenditure for the first time in FY 2023–24, signalling a major shift in India's innovation ecosystem.

Key Points

I. Major Findings

* India's Gross Expenditure on Research & Development (GERD) reached 0.83% of GDP in 2021–22, crossing the 0.8% mark for the first time since 2009–10.
* Private industry's share in total R&D expenditure increased from:
    * 45.5% (2021–22)
    * 48.0% (2022–23)
    * 51.8% (2023–24) (first time higher than all levels of government combined).

II. Surge in Private Investment

* Private sector R&D spending rose from:
    * ₹46,400 crore (2020–21) to
    * ₹88,600 crore (2021–22) and
    * ₹1,26,800 crore (2023–24).

Indicates that India's innovation ecosystem is becoming industry-driven rather than government-driven.

III. Global Comparison (R&D Expenditure as % of GDP, 2021)

* India – 0.64%
* China – 2.4%
* Japan – 3.3%
* United States – 3.5%
* South Korea – 4.8%
* Israel – 5.0%

Despite recent improvements, India's R&D intensity remains significantly below that of major innovation-driven economies.

IV. Why does it matter?

* Higher private-sector participation promotes commercialisation of research, innovation-led growth and Atmanirbhar Bharat.
* However, India still needs to increase overall R&D expenditure as a share of GDP, not just private participation, to compete with leading scientific nations.

India Emerges as World's Second-Largest Supplier of Seafarers

India's rise from FIFTH place in 2015 to the world's SECOND-largest pool of seafarers in 2026 is a result of the visionary leadership of PM Narendra Modi: Sarbananda Sonowal

India now Contributes 12.16% of the Global Maritime Workforce

Indian officers Constitute 13.41% of the World's officer workforce, reinforcing India's position as a global maritime talent hub

Mission 20% Aims to Make One in every Five Global Seafarers an Indian

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India has emerged as the world's second-largest supplier of seafarers, contributing 311,936 maritime professionals to the global shipping industry, according to the **BIMCO-ICS Seafarer Workforce Report 2026**. The report estimates that India now accounts for 12.16% of the global seafaring workforce, ranking behind only the Philippines and ahead of China, the Russian Federation and Indonesia.

Context (GS-III: Infrastructure – Ports, Shipping & Waterways | Economy – Maritime Sector)

According to the BIMCO–ICS Seafarer Workforce Report 2026, India has become the world's second-largest supplier of seafarers, highlighting its growing importance in the global maritime industry.

Key Points

I. Major Highlights

* India has improved from 5th place (2015) to 2nd place (2026) globally in supplying seafarers.
* India now contributes 12.16% of the global seafaring workforce.
* Mission 20% aims to make one in every five global seafarers an Indian.

II. Seafarer: A seafarer is a trained person employed on a merchant ship, responsible for navigation, engineering, cargo handling or other onboard operations.

III. Recent Issues Faced by Indian Seafarers

* Attacks by Houthi rebels in the Red Sea and Gulf of Aden have exposed Indian seafarers to security risks.
* Piracy incidents, particularly near the Gulf of Aden and the Somali coast, continue to threaten maritime safety.
* Ongoing geopolitical conflicts have led to detentions, delayed crew changes and disruptions to global shipping routes.

RBI to trial Rs 3k cr worth of Rs 10, Rs 20 plastic notes

New Delhi: The Reserve Bank of India's (RBI) trial of plastic notes will see the introduction of 100 crore pieces of Rs 10 and Rs 20 notes each, worth a total of Rs 3,000 crore, Minister of State for Finance Pankaj Chaudhary said in response to a question in Lok Sabha on Monday.

Chaudhary said following a recommendation from its central board, the RBI had sent a proposal to the Centre for the field trials "and for regular issuance of polymer banknotes in these two denominations after successful completion of field trials".

The proposal was approved by the government.

The MoS in the finance ministry added that according to the RBI, the polymer banknotes are proposed to be issued along with paper banknotes and "there is no proposal to replace paper currency with polymer substrate-based banknotes".

The mention of the two denominations of banknotes is the first official confirmation of which notes will be targeted in the RBI's field trials. **ENS**

Which one of the following statements about Unified Payments Interface (UPI) and Central Bank Digital Currency (Digital Rupee) is ***not*** correct ?

(a) UPI is a real-time payment system but Digital Rupee is akin to sovereign paper currency.

(b) In case of UPI, settlement for end users happens instantly as the money gets immediately debited or credited but in case of Digital Rupee, there is no settlement as the wallet balance gets transferred to another wallet.

(c) UPI transactions are recorded by banks and reflected in bank statements but in case of Digital Rupee, no data is captured in bank statements as transactions are from one wallet to another.

(d) In both the cases (UPI and Digital Rupee), the liability lies with the users and their respective banks.

1. **Context (GS III: Indian Economy – Banking & Currency Management | Prelims: RBI, Currency Management, Polymer Banknotes)**

The Reserve Bank of India (RBI) has received approval from the Central Government to conduct field trials of ₹10 and ₹20 polymer banknotes. The objective is to assess whether polymer banknotes are more durable, secure and cost-effective than the existing cotton-based paper notes. The RBI has clarified that these notes are only under trial and will not replace paper currency immediately.

2. **What are Polymer Banknotes?**

Polymer banknotes are currency notes printed on a special polymer (plastic) substrate instead of the conventional cotton-based paper substrate. The material is specifically designed for currency production and offers greater durability and enhanced security.

3. **Why is RBI Introducing Polymer Banknotes?**

I. Longer lifespan than cotton-based paper notes.
II. Better protection against counterfeiting through advanced security features.
III. Water-resistant and dirt-resistant, making them more durable.
IV. Lower long-term replacement cost despite higher initial printing cost.

4. **Will Polymer Notes Replace Existing Paper Notes?**

I. No. Polymer notes are currently being introduced only for field trials.
II. If successful, they will coexist with existing cotton-based paper notes.
III. There is no proposal at present to replace all paper currency.