



## Topics - MINDS MAPS included (Daily current affairs ) 13th November 2024

- Long Range Land Attack Cruise Missile (LRLACM)
- Carbon Emissions Report 2024
- Intelligent Bacteria development
- Uranus and Voyager 2 Findings
- IMEC
- MAINS



By saurabh Pandey



THE HINDU

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**Q “ IMEC Successful implementation depends on multiple factors “  
Discuss**

प्रश्न "IMEC का सफल कार्यान्वयन कई कारकों पर निर्भर करता है" चर्चा करें

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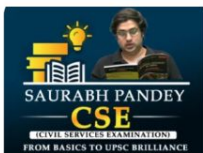
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# DRDO carries out test of long-range cruise missile

**The Hindu Bureau**

NEW DELHI

Defence Research and Development Organisation (DRDO) on Tuesday conducted the maiden flight-test of a Long Range Land Attack Cruise Missile (LRLACM), with a range of 1,000 km, from the Integrated Test Range, Chandipur off the coast of Odisha from a mobile articulated launcher. This is a new variant of *Nirbhay* LRLACM with improved features, officials confirmed.

The Defence Acquisition Council had approved procurement of the LRLACM in July 2020.

The missile has been developed by the Aeronauti-





The Long Range Land Attack Cruise Missile being launched off Odisha. SPECIAL ARRANGEMENT


cal Development Establishment, Bengaluru.


Once inducted, the LRLACM, similar to U.S. Tomahawk cruise missile, will give Indian armed forces a long-range standoff capability to strike targets on land.


## Topic → Long Range Land Attack Cruise Missile (LRLACM)

 Maiden Flight Test: DRDO conducted the first flight test of the Long Range Land Attack Cruise Missile (LRLACM) on Tuesday.

 Range: The missile has a range of 1,000 km, allowing for significant strike capabilities.

 Launch Site: The test was conducted from the Integrated Test Range in Chandipur, off the coast of Odisha.

 Improved Variant: This LRLACM is a new variant of the Nirbhay missile, featuring enhanced capabilities.

 Approval Date: The Defence Acquisition Council approved the procurement of the LRLACM in July 2020.



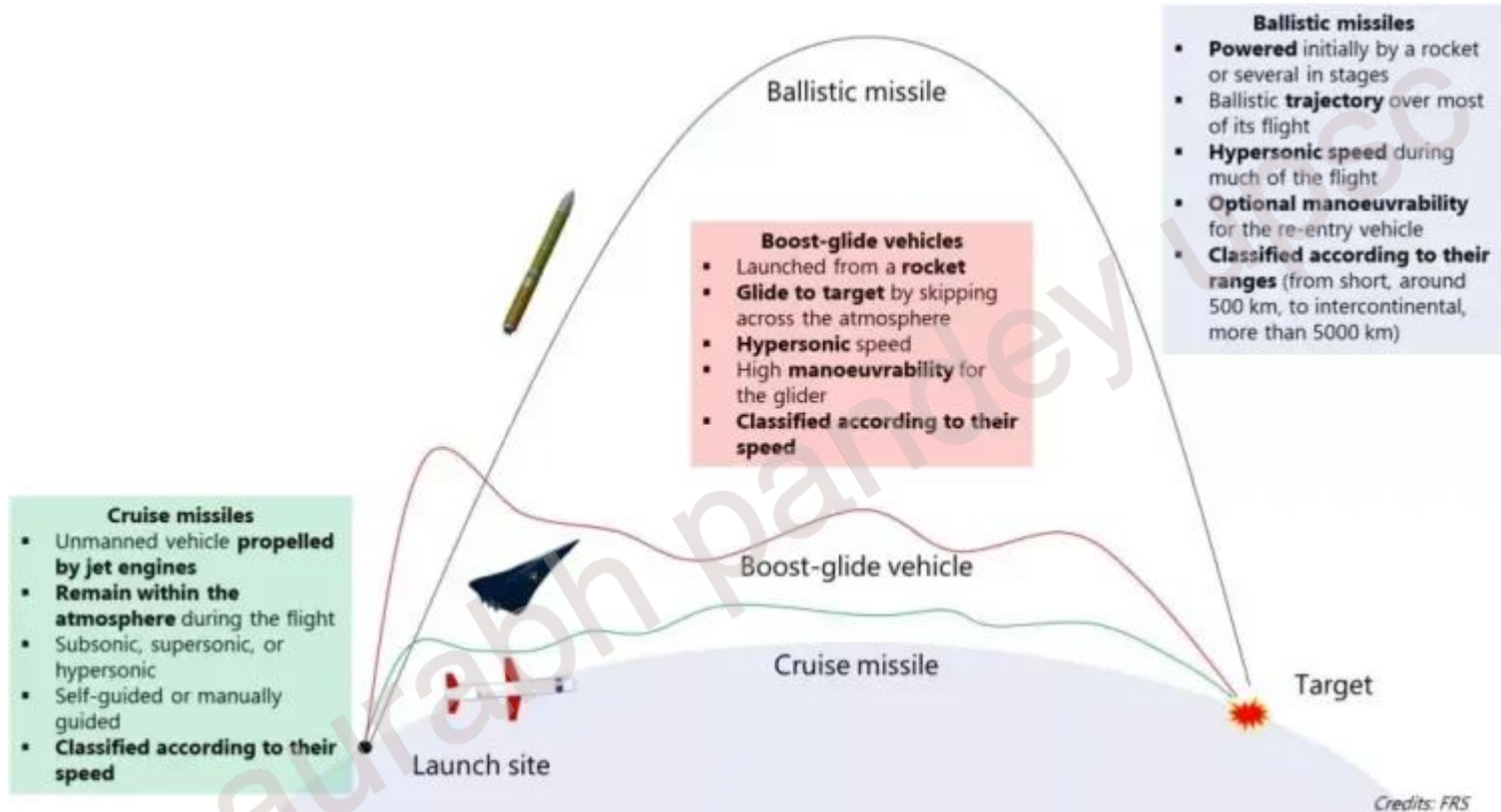
**Development:** The missile was developed by the Aeronautical Development Establishment located in Bengaluru.



**Strategic Capability:** Once inducted, the LRLACM will provide Indian armed forces with a long-range standoff capability similar to the U.S. Tomahawk cruise missile.

**Summary:** DRDO successfully tested a new variant of the Long Range Land Attack Cruise Missile with a 1,000 km range, enhancing India's strike capabilities.

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# Topic → Carbon Emissions Report 2024

## Overview of Carbon Emissions

### Global Emissions Rise

Expected increase of 0.8% in 2024

Previous rise of 1.2% in 2023

## Major Contributing Regions

### Top Contributors

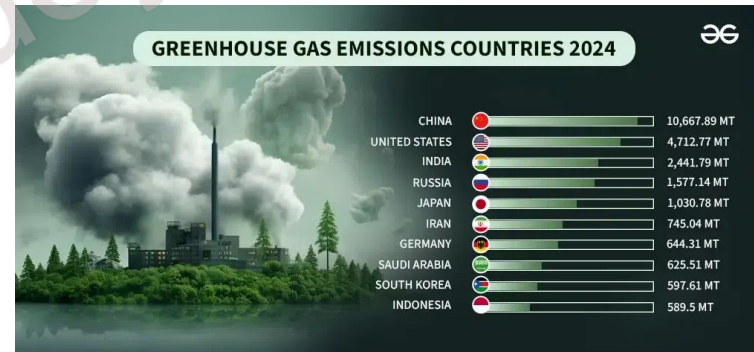
China: 31%

United States: 13%

India: 8%

EU-27: 7%

*Total of these four regions accounts for 59% of global fossil CO2 emissions*



# Emissions Per Capita

## Global Average

1.3 tonnes of CO<sub>2</sub> per person per year

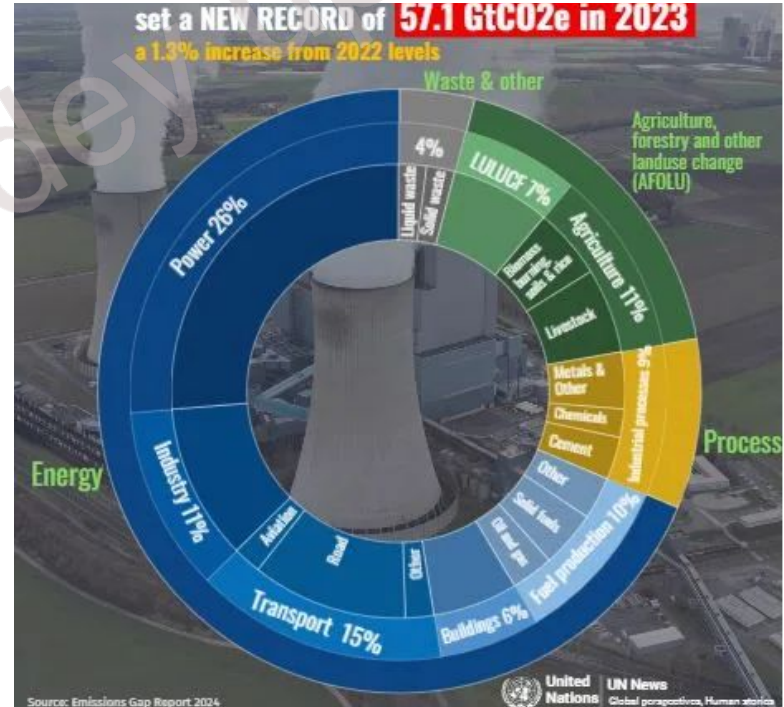
### Breakdown:

U.S.: 3.9 tonnes

China: 2.3 tonnes

EU-27: 1.5 tonnes

India: 0.6 tonnes



## Future Projections

India's Emissions



Expected increase by 4.6% in 2024

China's Emissions



Expected increase by 0.2%

## Global Carbon Budget (GCB) Insights

Annual peer-reviewed estimates of atmospheric carbon

2024 CO<sub>2</sub> Concentration: Set to reach 422.5 ppm

Paris Agreement Goals: Urgent need for emission cuts to maintain temperature below 2°C

## Climate Change Impacts

Increasingly dramatic effects of climate change observed

GCB predicts a 50% chance of breaching the 1.5°C target in about 6 years



# Team at Kolkata institute engineers bacteria to solve maths problems

Saha Institute of Nuclear Physics scientists introduced genetic circuits in bacteria that could be activated by a combination of chemical inducers then they combined bacteria with different engineered circuits in a solution to build bacterial computers that behaved like artificial neural networks

Science Daily  
01/27/17

**A**t the Saha Institute of Nuclear Physics, Kolkata, synthetic biologist Sangram Bagh has a major and somewhat unusual goal to build 'intelligent' bacteria.

Despite being single-celled, bacteria are very sensitive and responsive to their environments. Organisms that are generally called invertebrates – including dolphins, chimpanzees, octopuses, crabs, and humans – are on the other hand multicellular, with brains composed of billions of specialised cells called neurons.

But in a major breakthrough, Bagh's lab has engineered bacteria that can decide whether a given number is prime and whether an alphabet is a vowel. These could earlier be done only by humans or computers. Bagh said, "but now genetically engineered bacteria are doing the same. Such observations raise new questions about the meaning of intelligence."

Bagh's team introduced 'genetic circuits' in bacteria that could be activated by a combination of chemical inducers. Then they combined bacteria with different engineered circuits in a solution to build bacterial 'computers' that behaved like artificial neural networks. In this setting, each type of engineered bacteria was a "neuron" and the combination of bacterium behaved like a multicellular organism capable of abstract mathematics.

The team reported its findings in *Nature Chemical Biology* in September. The paper's publication has stirred significant interest among synthetic biologists – experts who engineer new abilities in organisms. For example, Jason Chin, executive director of the U.S. Center for Synthetic Biology and Biomaterials, Kochi said, "We've entered a time where bacteria can be programmed to solve mathematical problems through chemical 'connections'."

The creation of these bacterial computers could herald significant advances in the pharmaceutical industry and medical sciences and in the biomanufacturing sector. Chin added:

In an artificial neural network (ANN), processing units called nodes are connected to each other in layers. Each node takes in an input (or inputs), performs a computation on it, and produces an output – which can be the ANN's output or the input for another node. ANNs with more layers can perform more complex computational tasks.

Bagh's team used tools from molecular biology to introduce transcriptional genetic circuits in *Escherichia coli*, a bacteria commonly used in research.

During transcription, a bacteria transcribes a part of its DNA into RNA and reads from that RNA to make proteins. The scientist knows to which transcription factor protein called transcription factors recognise specific DNA sequences called promoters, and lack of transcription. The team built the genetic circuit in bacteria by introducing synthetic promoters that could be recognised by four transcription factors, individually or together. "The transcription factors and promoters and their interactions formed various feed-forward, feedback, and combination mechanisms," the authors wrote in their paper. Machine learning models use these mechanisms to perform their calculations.

In this way the researchers created 14 bacterium that could be brought together in different combinations, each working like a single-layered ANN. They tested each combination for its response to specific tasks. A combination could be switched 'on' by the presence or absence of four chemical compounds in the solution containing the bacteria.

The chemistry of input and output  
Conventional computers manipulate the voltage of electrical circuits via math of logic to perform calculations. High voltage is the 'on' state represented by 1, and low voltage is the 'off' state represented by 0. To mimic this in a bacterial computer, Bagh's team coded their problems first in the language of 0s and 1s and translated this to the presence (or absence) of the chemical inducers. For example, to ask a bacterial computer a number between 0-9 is prime, the team first converted it to binary, then used the 0s and 1s in the binary form to present or withhold the chemicals. If the presence of chemicals one, two, and three (111), and the absence of chemical four (0) would read by the bacterial computer as 7, while the

## Is n a Prime Number?

n	Bits				Yes	No
	(X4) ARA	(X2) IPTG	(X3) aTc	(X1) AHL		
0	0	0	0	0	0	1
1	0	0	0	1	0	1
2	0	0	1	0	1	0
3	0	0	1	1	1	0
4	0	1	0	0	0	1
5	0	1	0	1	0	1
6	0	1	1	0	0	1
7	0	1	1	1	1	0
8	1	0	0	0	0	1
9	1	0	0	1	0	1



A table from the study showing the input and the output for a bacterial computer calculating whether a given number is prime. ARA, IPTG, aTc and AHL are the chemical inducers. Green and pink boxes indicate the representation of green and orange fluorescent proteins, respectively. [Source: Chin et al.](#)

absence of chemicals one, three and four, and the presence of chemical two would signal '4'. Similarly, the team understood the output by checking for the presence or absence of red and green fluorescent proteins, engineered from the bacteria along with the genetic circuits.

In ANNs, the relationship between the output and the input of a node is captured in an equation called the activation function. When we write  $f(x, y) = x$ , we're using the language of mathematics to say that the value of a depends in a specific way on the values of  $x$  and  $y$ . Similarly, the activated function uses the value of the bacterium's output depends on (i) the strength of the input; (ii) its relative importance with respect to other inputs called the weight; and (iii) a constant added to the weighted sum of all inputs, called the bias.

A node is activated when the weighted sum of the inputs plus the bias crosses a threshold. The weighted sum is calculated by multiplying the weight of each input with its strength and adding such terms for all inputs. For example, if  $x$  and  $y$  are  $1$  and  $1$  with weights  $w$  and  $w'$ , the weighted sum would be  $w + w'$ .

According to Bagh, all ANNs have a similar activation function in form. The differences arise due to the inputs and their weights. Whether each bacterium produced red or green fluorescent proteins was contingent on its activation function that captured whether a certain concentration of chemical inducers, their weights (i.e. each inducer's ability to trigger a genetic circuit relative to other inducers), and a bias (which the team is yet to explain in molecular terms) crossed a threshold.

According to Bagh, the team did not "do" designing, constructing, and optimising the artificial genetic circuits such that the given chemical signals are recognised and processed by the circuits one, two, and three (111), and the absence of chemical four (0) would read by the bacterial computer as 7, while the

**A striking feature of the work of Bagh et al. is that the bacterial computers are able to work on progressively more complex tasks**

and their absence as 0 (0's). A combination of 0s and 1s could be used to read the output as "yes" or "no".

When the team asked the bacterium computer if 7 is prime, it responded "yes" by expressing green fluorescent protein (0) but not the red.

The computer could also say whether a number between 0 and 9 was a perfect power (a number that can be expressed as one integer raised to another; e.g. 8 is a perfect power because  $8 = 2^3$ ) and whether a letter between A and I was a vowel. It was first recognised by this success, the team raised the ante by having the computer answer more complex questions. They were able to say whether adding three or an integer would create a prime number (e.g.  $7 + 3 = 10$  prime "no") and whether the square of a certain number could be expressed as the sum of three factors.

Next-level optimisation  
Finally, the researchers tested whether the bacterium could solve problems that couldn't be tackled with yet-to-be answers. For this, they added one computer to find the maximum number of pieces cutting a pie using a fixed number of straight cuts would create. This is an example of an optimisation problem, where researchers try to identify the best solution from a pool of possible solutions.

The team input the number of straight cuts in the form of chemical signals, using green and red. The output in this case would have to be a number, the team predicted some bacterium to express other fluorescent proteins (like and red) in addition to green and the

crimson ones. The presence or absence of these fluorescent proteins could be read in binary and converted to decimal.

When they asked the computer to solve the problem for two straight cuts, it didn't express the orange fluorescent protein (0), and didn't express either the green or crimson fluorescent protein (0). 000, 0000 in binary is 4 in decimal, and the correct answer. Then they asked to solve for four straight cuts, and the computer responded by expressing green fluorescent protein (0), and expressing both the green and crimson ones (0). Together, 001 in the code of the decimal number 1, again the correct answer.

Revealing new ground  
Ajay Mandal, a professor of computational biology at the Institute of Mathematical Sciences, Chennai, said a striking feature of the work of Bagh et al. was that the bacterial computers are able to work on progressively more complex mathematical and computational tasks. Calling the paper "groundbreaking", he said the field-based synthesis, he added, said for future may not be far off where such biocomputers "recognise the molecular patterns of cancer at its earliest stage, signal for precise treatment, and administer localized treatments before tumours even form."

He added that as artificial-grown bacterial computers with the ability to perform more complex "computational" tasks could be constructed in microbes, reducing the time of the traditional silicon-based computers.


Whereas for the study reintegrating his hunger for more innovations in biocomputing, Bagh, his engineered bacterium are able to generate "bits" about the biological nature of intelligence.

Source: [Science Daily](#) (a science journal) and a faculty member at King University.



# Topic → Intelligent Bacteria development

## Intelligent Bacteria Development

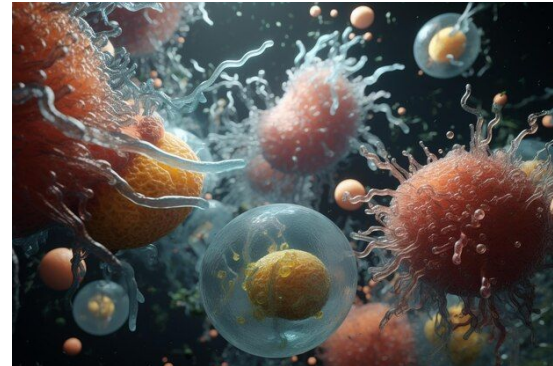
Objective: Build **intelligent bacteria** at Saha Institute of Nuclear Physics, Kolkata 

Key Concepts:

Understanding of **intelligence** in single-celled vs. multicellular organisms



Developing bacteria that can solve mathematical problems like prime number detection and vowel identification  



# Genetic Engineering Techniques

Genetic Circuits:

Activation via `chemical inducers` 🧪

Combination of engineered circuits to form `bacterial computers` 🖥️

Bactoneurons:

Engineered bacteria acting as `neurons` in artificial neural networks (ANNs)



Capability of performing tasks through combinations and interactions of

`bactoneurons` ↻

## Research Findings

Published in `Nature Chemical Biology` 📜

Significant interest in synthetic biology and engineering new organism abilities 🔍

Expert Opinions:

Comments from Pawan Dhar on programming bacteria for mathematical tasks 🗨️

# Applications and Implications



Potential advances in:

Pharmaceutical Industry 

Medical Sciences 

Biomanufacturing Sector 

## Methodology

Molecular Biology Tools:

Introduction of transcriptional genetic circuits in *Escherichia coli* 

Use of transcription factors and synthetic promoters for circuit building 

ANN Structure:

Nodes connected in layers for computational tasks 

Testing Combinations:

Examining abilities of 14 different *bactoneurons* for specific tasks 

Uranus is the first planet to be discovered with the aid of a telescope. FILE PHOTO

## Scientists uncover a mix-up about Uranus

Reuters

In 1781, German-born British astronomer William Herschel made Uranus the first planet discovered with the aid of a telescope. This field planet, our solar system's third largest, remains a bit of an enigma 243 years later. And some of what we thought we knew about it turns out to be off the mark.

Much of the knowledge about Uranus was gleaned when NASA's robotic spacecraft Voyager 2 conducted a five-day flyby in 1986. But scientists have now discovered that the probe visited at a time of unusual conditions — an intense solar wind event — that led to misleading observations about Uranus, and specifically its magnetic field.

The solar wind is a high-speed flow of charged particles emanating from the sun. The researchers took a fresh look at eight months of data from around the time of Voyager 2's visit and found that it encountered Uranus just a few days after the solar wind had squashed its magnetosphere, the planet's protective magnetic bubble, to about 20% of its usual volume. "We found that the solar wind conditions present during the flyby only occur 4% of the time. The flyby occurred during the maximum peak solar wind intensity in that entire eight-month period," said space plasma physicist Jamie Jasinski of NASA's Jet Propulsion Laboratory, lead author of the study published on Monday in the journal *Nature Astronomy*.

**The Voyager 2 observations left a misimpression about the magnetosphere of Uranus as lacking in plasma and possessing uncommonly intense belts of highly energetic electrons**

"We would have observed a much bigger magnetosphere if Voyager 2 had arrived a week earlier," Jasinski said. Such a visit likely would have shown that the Uranus magnetosphere is similar to those of Jupiter, Saturn, and Neptune, the solar system's other giant planets, the researchers said. A magnetosphere is a region of space surrounding a planet where the planet's magnetic field dominates, creating a protective zone against solar and cosmic particle radiation. The Voyager 2 observations left a misimpression about the magnetosphere of Uranus as lacking in plasma and possessing uncommonly intense belts of highly energetic electrons.

Plasma — the fourth state of matter after solids, liquids, and gases — is a gas whose atoms have been split into high-energy subatomic particles. Plasma is a common feature in the magnetosphere of other planets so its low concentration observed around Uranus was puzzling. "The plasma environment of any planetary magnetosphere is usually formed of plasma from the solar wind, plasma from any moons present inside the magnetosphere and plasma from the atmosphere of the planet," Jasinski said.

"At Uranus, we did not see plasma from the solar wind or from the moons. And the plasma that was measured was very tenuous," Jasinski said.

Uranus has 28 known moons and two sets of rings. The Voyager 2 observations had suggested that its two largest moons, Titania and Oberon, often orbit outside



# Topic → Uranus and Voyager 2 Findings

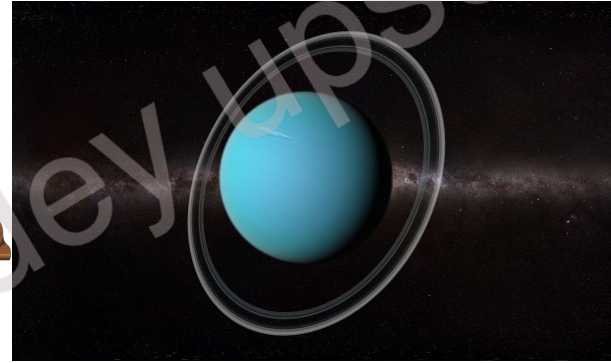


## Overview of Uranus

Discovered by William Herschel in 1781 

Third largest planet in the solar system

Remains an enigma even after 243 years 



## Voyager 2 Mission

Conducted a flyby in 1986 

Provided much of the current knowledge about Uranus

Encountered unusual solar wind conditions during the flyby 

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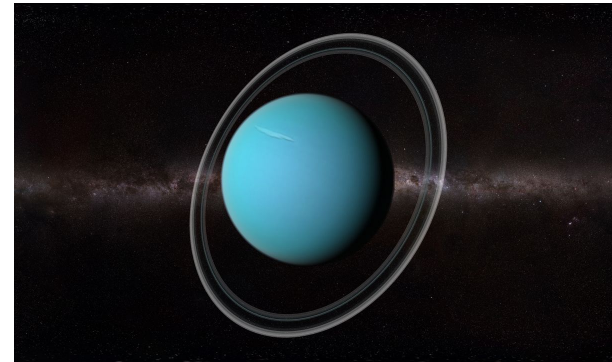
## Key Findings

Magnetosphere: Observed to be only 20% of its usual volume during the flyby



Solar Wind Effects: Encountered during maximum intensity, leading to misleading observations ☠️

Plasma Environment: Low plasma concentration was puzzling, as it is typically present in other planetary magnetospheres 🌀



## Implications of Findings

Suggests Uranus's magnetosphere may be more similar to Jupiter and Saturn than previously thought 🤔

New understanding of the plasma and magnetic field dynamics around Uranus

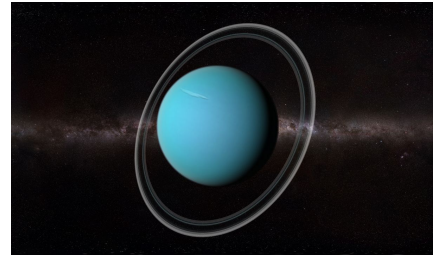
Indicates potential for subsurface oceans on its moons, Titania and Oberon



## Future Research Directions

Need for re-evaluation of past observations and data 📊

Explore the possibility of life on Uranus's moons 🧬



# A mixed report card for the IMEC



In September 2023, the ambitious transcontinental India-Middle East-Europe Corridor (IMEC) was announced on the sidelines of the G20 summit in New Delhi. The proposed corridor is expected to reduce the transit time between its eastern and western nodes by 40%, and costs by 30%, compared to transportation via the Suez Canal. These numbers may vary as the actual benefits may end up being on the lower side, but there is no denying that the new corridor, once operational, will be a game changer for the international maritime trade. Therefore, it is important to understand how the idea has shaped since its announcement and what lies ahead of it.

## Progress on both ends

Over the past year, various challenges have delayed progress on the project. The announcement of the corridor came with much optimism. However, this did not last long, as the very premise which led to the conception of this idea, namely, the normalisation of Arab-Israel relations, came to a sudden halt with the escalation of the conflict between Israel and Palestine on October 7 last year. This crisis engulfed the whole of West Asia for the larger part of the year, which put the corridor on the back-burner. As a result of the temporary pause, two key stakeholders, Saudi Arabia and Jordan, have not been able to make any progress on the project. Though it may be argued that the official relations between Arab countries and Israel won't impact completion of work on the ground, the two governments, which will have to work closely with the Israeli establishment for the project, would not want the optics and its geopolitical dimension. Therefore, implementation on the northern part of the corridor, which is mostly in West Asia, is going to move slowly until the ongoing escalation subsides.



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Implementation on the northern part of the corridor is going to move slowly until the West Asian conflict subsides, while progress is faster on the eastern leg connecting the UAE and Indian ports

On the eastern leg of the corridor connecting the United Arab Emirates (UAE) and Indian ports, things are moving forward at a relatively fast pace. The economic relations of the two countries are on a northward trajectory, which is also reflected in the increasing bilateral trade numbers. Post the signing of the Comprehensive Economic Partnership Agreement (CEPA) in 2022, bilateral trade has grown from \$43.30 billion in 2020-21 to \$83.64 billion in 2023-24 (a staggering 93%). Another important feature of the growing bilateral trade is the diversification of the trade basket between the two countries, which is reflected in the growing non-oil trade. The non-oil trade between India and the UAE grew from \$28.67 billion in 2020-21 to \$57.81 billion in 2023-24. This represents a healthy shift from an Indian perspective, considering that most of these commodities will be transported further west and north through the IMEC, thereby improving India's export share in the larger region.

Beyond amplifying trade volumes, the two countries are also working on the standardisation and facilitation of trade processes. Recently, India and the UAE launched the Virtual Trade Corridor. This will be an integral part of the IMEC, aimed at the reduction of administrative processes and time, reduction of logistics and transportation costs, and ease of doing trade. The streamlining of trade processes would not only serve bilateral relations, but also pave the way and provide a working model for other countries involved in the IMEC to develop similar frameworks for cross-border trade facilitation.

After more than a year since the IMEC was announced, we see an uncertain western part of the corridor trying to navigate through the conflict and a committed eastern part that is forging new linkages to ready itself for the new maritime order.

Further, given the one-year progress and the situation on the ground, it is clear that only the connectivity aspect of the IMEC initiative is gaining some traction at the moment. Other elements of the corridor, including clean energy export, undersea fiber-optic cables and pipelines, energy grid linkages, telecommunication lines, and clean energy technology cooperation, will have to wait till the situation in West Asia normalises. Therefore, the countries on the eastern part of the corridor should use this time to develop their capacity to improve connectivity among them.


## What India can do


India, especially, can use this time to prepare its ports, develop specific economic zones along the connectivity nodes, and improve its domestic logistics for seamless integration with the IMEC. There is a need to improve the digital footprint in the domestic logistics landscape, which will help reduce logistics time and costs, thereby making Indian exports more competitive. Further, the corridor, as ambitious as it may be, is just the means. The actual benefits will be seen only if India can improve its integration in the global value chains. With IMEC, India aims to position itself as a global supply chain alternative. This can only happen if the country takes steps towards enhancing its manufacturing competitiveness.


Finally, it is time to push for the IMEC secretariat, which can make the structure and working of the IMEC more organised. For starters, the secretariat can work on developing the framework for streamlining the cross-border trade processes and empirical evidence-based research on benefits accruing to participating countries. This would help countries in the neighbourhood of the corridor to better understand the project. This may end up generating interest, which could result in them joining it.


## Topic - IMEC



 **Announcement of IMEC:** The India-Middle East-Europe Corridor (IMEC) was announced in September 2023 during the G20 summit in New Delhi.

 **Reduced Transit Time:** The corridor is expected to reduce transit time between eastern and western nodes by 40%.

 **Cost Savings:** Transportation costs are anticipated to decrease by 30% compared to the Suez Canal route.

 **Challenges and Delays:** Progress on the project has faced delays due to geopolitical tensions, particularly the Israel-Palestine conflict that escalated on October 7, 2022.



Piraeus

Haifa

Al Haditha


Riyadh


Haradh


Al Ghweifat

Dubai/Jebel Ali


Mumbai


 **Stakeholder Involvement:** Key stakeholders, including Saudi Arabia and Jordan, have been unable to advance the project due to the ongoing conflict.

 **Geopolitical Implications:** The normalization of Arab-Israel relations is crucial for the corridor's success, but current tensions hinder cooperation.


 **Slow Implementation:** The northern part of the corridor, primarily in West Asia, is expected to progress slowly until the regional conflict subsides.

saurabh pandey ipsc


 **Bilateral Trade Growth:** Trade between the UAE and India surged from \$43.30 billion in 2020-21 to \$83.64 billion in 2023-24, marking a 93% increase post-CEPA signing in 2022.


 **Diversification of Trade:** Non-oil trade between the two nations rose from \$28.67 billion in 2020-21 to \$57.81 billion in 2023-24, indicating a healthy diversification in trade commodities.


 **Virtual Trade Corridor:** India and the UAE launched a Virtual Trade Corridor to streamline trade processes, reduce logistics costs, and enhance ease of doing business.

 **IMEC Integration:** The Virtual Trade Corridor is part of the India-Middle East-Europe Economic Corridor (IMEC), aimed at improving trade facilitation and serving as a model for other countries.



 Eastern Corridor Commitment: The eastern leg of the IMEC is progressing well, while the western part faces challenges due to regional conflicts.


 Future Prospects: Other elements of the IMEC, such as clean energy exports and telecommunication links, are on hold until stability in West Asia is achieved.


 Capacity Building: Eastern corridor countries are encouraged to enhance their connectivity capabilities during this period of uncertainty.

saurabh pandey UPSC


# What india can do ??





 Port Development: India should focus on preparing its ports and developing specific economic zones along connectivity nodes.


 Logistics Improvement: Enhancing domestic logistics is crucial for seamless integration with the International Multi-Modal Connectivity (IMEC) initiative.

 Digital Footprint: There is a need to improve the digital landscape in logistics to reduce time and costs, making Indian exports more competitive.

 Global Value Chains: India aims to enhance its integration into global value chains to position itself as a viable global supply chain alternative.

 Manufacturing Competitiveness: Steps must be taken to improve India's manufacturing competitiveness to fully benefit from the IMEC.

 IMEC Secretariat: Establishing an IMEC secretariat is essential for organizing the structure and operations of the initiative.

 Research and Awareness: The secretariat can facilitate research on cross-border trade processes and benefits, potentially attracting neighboring countries to join the project.

Summary: India has the opportunity to enhance its logistics, manufacturing, and global integration through the IMEC initiative, which requires the establishment of a dedicated secretariat for better organization and research.

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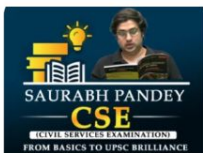
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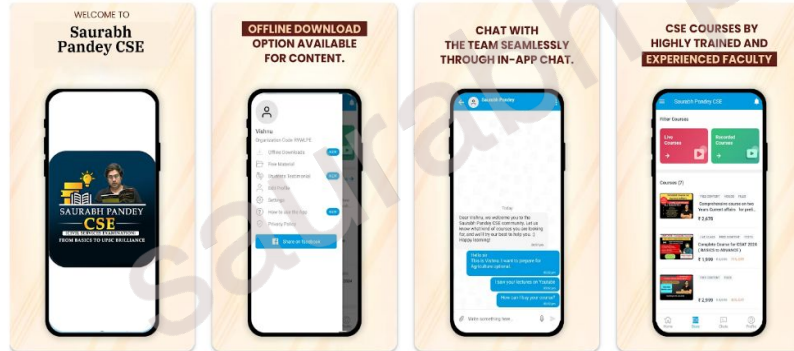
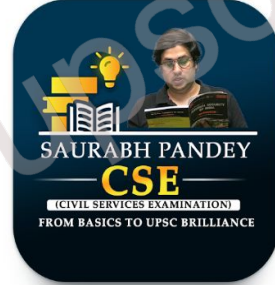
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