EDITORIAL HIGHLIGHTS

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GS 2: INTERNATIONAL RELATIONS THE HINDU PAGE: 01

Free Indo-Pacific priority for India, Japan: PM

Both countries are 'perfectly aligned', Japanese PM says and stresses on 'strategic cooperation'

Countries seal at least 129 MoUs on technology, investment and AI; Japan may invest $1 trillion

Modi praises deal over defence tech for maritime security; Takaichi expresses concern over Gulf

Saurabh Trivedi
Kallol Bhattacherjee
NEW DELHI

A "free and rules-based Indo-Pacific" is a common priority for India and Japan, Prime Minister Narendra Modi said on Thursday while welcoming his Japanese counterpart, Sanae Takaichi. Mr. Modi said India and Japan would jointly develop technologies that would help in maintaining maritime security and "regional peace".

"India and Japan are among the biggest economies of the world. A free, prosperous and rules-based Indo-Pacific is our shared priority. We will jointly pave the way for peace, stability and progress for the entire region," Mr. Modi said.

"In the field of defence, India and Japan have done the first agreement for co-development of projects. This agreement on naval radio antenna will open a new chapter of defence technology partnership. Now, we will jointly develop such technologies that will help in maintaining regional peace, maritime security, and strengthen rules-based order," Mr. Modi added.

Maritime security

Ms. Takaichi, who arrived in New Delhi on July 1 for her first visit to India as Prime Minister, renewed her call for an updated free and open Indo-Pacific (FOIP) and emphasised the need for "strategic cooperation". She said that the two countries were "perfectly aligned".

Boosting ties: Prime Minister Narendra Modi with his Japanese counterpart Sanae Takaichi in New Delhi. SHIV KUMAR PUSHPAKAR

Mr. Modi and Ms. Takaichi attended an economic session in which Indian and Japanese companies sealed 129 memoranda of understanding on technology, investment, and artificial intelligence.

According to a document shared by the External Affairs Ministry, Japan is on track to invest $1 trillion across States, including Haryana, Odisha, Maharashtra, Gujarat, and those in the northeastern region.

Ms. Takaichi highlighted the importance of maritime security as the key to maintaining regional stability in the Indo-Pacific.

"Expansion of maritime security is especially important for regional peace and stability," Ms. Takaichi said, highlighting the harmony between Japan's call for FOIP and the Government of India's emphasis on ocean as a "shared space" that can sustain economic growth and safeguard sovereignty.

"In the midst of international affairs in disarray, the establishment of such an inter-complementary cooperative relationship has become ever more important," she stated.

She expressed concern about the situation in the Gulf region, where at least 31 Japanese vessels remain stranded near the Strait of Hormuz.

Defence cooperation

The two sides also announced deepening of bilateral defence cooperation through joint military exercises, particularly naval exercises in the Indian Ocean and expanding Maritime Domain Awareness.

Interacting with the media on Thursday evening, Japanese officials said that bilateral cooperation in defence equipment and technology was progressing through industry agreements. They emphasised that the defence technologies being exported were intended for "defence purposes and not for warfare".

The two sides highlighted the need to collaborate in addressing energy security needs against the backdrop of the disruption in the Persian Gulf region and supported the idea of "strategic stockpiling of crude oil" to serve bilateral requirements. Japan is diversifying energy suppliers in the backdrop of the crisis in West Asia, said Japanese officials.

Modi, Takaichi unveil Maruti Suzuki plant

NEW DELHI

At the India-Japan Joint Economic Forum on Thursday, Narendra Modi and Sanae Takaichi inaugurated Maruti Suzuki's fourth vehicle manufacturing facility at Kharkhoda in Haryana. This plant will be one of the largest, Suzuki Motors head Toshihiro Suzuki said. » PAGE 12

GS 2: AI IN JUDICIARY THE HINDU PAGE: 01

SC quashes NCLT order for using AI-generated case law

Aaratrika Bhaumik
NEW DELHI

Observing that the use of non-existent or AI-generated hallucinated judicial precedents is "catastrophic" to the judicial process, the Supreme Court on Thursday set aside an order of the National Company Law Tribunal (NCLT) after finding that it had relied on fictitious AI-generated case laws.

A Bench comprising Justices P.S. Narasimha and Alok Aradhe underscored that courts must adopt a "zero-tolerance" approach towards the reliance on AI-generated precedents without independent verification as it "contaminates" the very "lifeblood of judicial determination".

"Even if an iota of fake or hallucinated material enters the decision-making process, it would violate the sanctity of adjudication. It is absolutely necessary to maintain integrity in decision-making, and we reiterate and declare zero tolerance for the Bar as well as the Bench to cite, refer to, or rely on such material," the Bench said.

Cautioning against AI-generated hallucinations quietly permeating legal practice, it warned that reliance on fictitious precedents "subverts the rule of law".

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> **SUPREME COURT BENCH**

'Frame norms'

While acknowledging that "increased workloads of modern life" have compelled lawyers and judges to adapt to AI to improve efficiency, it underlined that meaningful human oversight must remain integral to every stage of the adjudicatory process.

"For us, i.e., for those in the province of adjudication and determination of disputes, this by-product of AI, i.e., the production of fake, non-existent, and hallucinated material and its utilisation as precedents in law, is like the release of methyl isocyanate in the province of law and justice: invisible, insidious, and catastrophic by the time anyone notices," the Bench said.

The top court called for a "deeper collaboration" between the Bar and the Bench on AI and urged the Bar Council of India to frame norms to address the issue of AI-generated precedents.

It noted that the process had already begun with the court publishing the Draft Regulations for Use of Artificial Intelligence in Courts, 2026, for public consultation.

The draft regulations provide that AI systems may function only in an assistive capacity and cannot supplant the role of judges. They also require disclosure of AI-assisted filings and prohibit the use of AI in judicial decision-making.

To address the growing instances of AI-generated hallucinated precedents being cited before courts, the Bench directed the (BCI), the apex statutory body regulating the legal profession, to constitute a committee to examine the issue and formulate appropriate norms.

The top court was hearing an appeal filed by Pooja Ramesh Singh, a suspended director of Essel Infraprojects Ltd., challenging the NCLT decision to admit the company into the corporate insolvency resolution process on an application filed by Jammu and Kashmir Bank under Section 7 of the Insolvency and Bankruptcy Code. The insolvency proceedings arose out of an alleged default in relation to a ₹200-crore credit facility extended by Jammu and Kashmir Bank to Pan India Utilities Distribution Company Ltd.

The Mumbai Bench of the NCLT admitted the insolvency application in August after recording a claimed default of ₹87.43 crore.

The order was subsequently affirmed by the National Company Law Appellate Tribunal (NCLAT).

Integrity of process

The apex court expressed surprise that the NCLAT had failed to notice that the NCLT's order relied on fictitious judicial precedents. It also cautioned that courts and tribunals should not "implicitly trust lawyers" with regard to authorities cited before them without independently verifying them.

The apex court held that the source of the lapse did not diminish its adverse impact on the integrity of the judicial process.

The court set aside the orders of both the NCLT and the NCLAT and remitted the matter to the tribunal for fresh consideration in accordance with law.

Can space oncology revolutionise cancer treatment?

Even as the burden of cancer is rising in India, space oncology is a rapidly emerging field, investigating how microgravity and cosmic radiation impact cancer progression and treatment

K. Ganapathy

Cancer is a group of diseases where abnormal cells grow uncontrollably, invading nearby tissues and sometimes spreading to distant organs of the body. In India, an estimated 1.87 million new cases are likely to be diagnosed in 2026, which means 1 in 9 Indians reading this article are at a lifetime risk of developing cancer.

Damage wreaked on the body apart, cancer is one of the most economically disruptive illnesses for families. Every year, ₹3,400 crores is spent on direct and indirect medical costs for cancer: this, however, excludes income loss, debt, asset depletion and caregiver burden.

It is no wonder then, that with the burden of cancer rising in India and globally, that it is one of the most widely-studied diseases in the world. And it is this research that has led to the emergence of what could perhaps become a new frontier in cancer treatment: space oncology.

Latest advances: Cancer is biologically diverse. Understanding divergent mechanobiological responses helps identify signalling pathways fundamental to metastasis, tissue invasion and treatment resistance. ISTOCKPHOTO

> When it comes to drugs, researchers have found that microgravity changes the cytoskeleton and spheroid formation of cells, which can help hasten drug discovery and also lead to reduced animal testing for drugs. As microgravity also allows for more uniform protein crystals and lower-viscosity biologics, this could help develop more stable formulations.

What is space oncology?

Space oncology is a rapidly emerging field, investigating how microgravity and cosmic radiation impact cancer progression and treatment. Space is a natural laboratory for studying cancer biology. Space-based environments are studied to accelerate tumour modelling and drug discovery.

Space oncology has already produced useful, conceptual and technological spin-offs, ranging from 3D cell-culture systems to protein-crystal studies for cancer drug development. This is in addition to refined thinking about radiation risk, tissue response and biomarker discovery.

Why this is useful?

Cancer is biologically diverse. Understanding divergent mechanobiological responses helps identify signalling pathways fundamental to metastasis, tissue invasion and treatment resistance.

Some cell changes that have been identified as a result of microgravity are cytoskeletal reorganisation, altered focal-adhesion signalling, changes in extracellular-matrix interactions and spontaneous formation of multicellular spheroids. Each is relevant to tumour spread and therapeutic response.

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Microgravity also changes the tumour-cell biology that drugs act on, and improves performance of delivery systems such as nanoparticles and 3D formulations. The effects of microgravity on cancer cells, cancer stem cells, and drug response therefore, could help future therapeutic strategies.

International Space Station (ISS) studies have covered real-space and simulated-microgravity experiments across breast, lung, thyroid, prostate, melanoma, glioblastoma and hematologic cancer models. Cancer cells studied in microgravity and exposed to unique radiation environment of space behave differently than in conventional laboratory systems. These differences reveal mechanisms that are otherwise difficult to understand.

Reviews of real-space and simulated microgravity experiments show effects on cell adhesion, migration, proliferation, gene expression and formation of multicellular spheroids.

On microgravity

Microgravity also changes how tiny drug packages (nanoparticles) form. These particles carry chemotherapy directly into the tumours and release it slowly. Microgravity reorganises cancer-cell shapes, membrane behaviour and gene expression. This alters how cells take up drugs. Remove or reduce gravity, and cells experience major changes in fluid behaviour, mechanical loading and cell-to-cell interaction.

For cancer cells, these changes are not trivial. In microgravity, protein crystals and complex biologics form more slowly and uniformly without gravitational sedimentation. Microgravity, therefore, helps produce drug crystals and biologic formulations that are harder to make on Earth.

Breast & GI cancer in outer space

Breast cancer cells show changes in gene expression, morphology, signal transduction and invasive behaviour under microgravity. In a microgravity environment of space, breast cancer cells generally shift toward a less malignant and less aggressive phenotype. Under normal gravity, breast cancer cells attach strongly to their surrounding matrix using focal adhesions. In space, these adhesion points fail to mature, reducing the cells' ability to crawl, migrate, and metastasize. Key proteins that regulate cell cycle checkpoints, specifically cyclin D1 and cyclin B1, are heavily downregulated, pausing the division process and stopping the rapid colony-forming ability of the tumour. Breast cancer spheroids grown in space are more susceptible to specialised therapies.

Gastrointestinal and colorectal cancer, however, react to microgravity by accelerating their disease trajectory and become more aggressive. Reduced expression of drug-resistance genes, increased DNA/RNA damage markers, and reorganisation of the protein, F-actin, make gastric cancer cells more sensitive to the chemotherapy drug, doxorubicin.

Regulations and investments

In 2025, the United States' Food and Drug Administration (FDA) approved a subcutaneous form of an immunotherapy drug, pembrolizumab.

The U.S. space agency, NASA, had developed this through protein crystal growth research performed on the ISS, targeting the ADAR1 gene. These crystals were more uniform and better suited to supporting formulation work for this route of delivery.

Similarly, rebecsinib, became the first space-tested cancer drug to enter clinical trials. Following successful ISS-linked testing it received the FDA 'Investigational New Drug' status. Microgravity-grown tumour organoids helped demonstrate antitumor activity strong enough to support further regulatory progression.

These cases show that space-based research is now a legitimate pathway for drug development, not just a novelty.

This year, United Kingdom regulators and the U.K. Space Agency publicly backed the development of a regulatory pathway in outer space.

The Medicines and Healthcare Products Regulatory Agency (MHRA), the Civil Aviation Authority (CAA), and the Regulatory Innovation Office have streamlined inter-agency bureaucracy. The specific 'dual-regulation' hurdles that previously made space-based pharmacology legally risky for heavy corporate investment were addressed.

This has enabled startups to engineer highly stable, concentrated cancer therapies that patients can self-inject at home instead of hours-long IV infusions. For companies, the costs of setting up a factory are removed; instead they may be able to deploy compact units that operate independently in orbit.

The Indian Space Research Organisation (ISRO), in spite of a modest $13 billion space economy, is the third- largest space-tech power globally and fifth among major government space agencies. Falling launch costs and new commercial platforms are making space oncology and space pharmaceutical manufacturing more realistic. With successful space startups in India the prices may fall further.

Space manufacturing is no longer about research. The picture is clear: the industry is moving from proof-of-concept to commercial production.

The microgravity pharmaceutical manufacturing market valued at $1.5 billion in 2025 is projected to reach $9.8 billion by 2034. Commercial space stations and nano/microsatellites (CubeSats) are now essential platforms for experiments. Small, frequent launches are becoming viable for pharmaceutical payloads.

What the future holds

Over 700 peer reviewed papers, 40 chapters and 12 monographs have already been published in the area of space oncology. At present, space oncology can be encapsulated by the well known saying: 'A journey of a thousand miles begins with the first step.' There is no doubt that humans will exploit outer space in the perpetual quest to solve the cancer conundrum on planet Earth.

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THE GIST

- Space oncology is a rapidly emerging field, investigating how microgravity and cosmic radiation impact cancer progression and treatment. Space is a natural laboratory for studying cancer biology. Space-based environments are studied to accelerate tumour modelling and drug discovery
- Microgravity changes how tiny drug packages (nanoparticles) form. For cancer cells, these changes are not trivial. In microgravity, protein crystals and complex biologics form more slowly and uniformly without gravitational sedimentation. Microgravity, therefore, helps produce drug crystals and biologic formulations that are harder to make on Earth
- The microgravity pharmaceutical manufacturing market valued at $1.5 billion in 2025 is projected to reach $9.8 billion by 2034. Commercial space stations and nano/microsatellites (CubeSats) are now essential platforms for experiments. Small, frequent launches are becoming viable for pharmaceutical payloads

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A shot at life, Mandsaur's model for HPV vaccination

Aditi Garg

Collector and District Magistrate, Mandsaur, Madhya Pradesh

This district in Madhya Pradesh has demonstrated effective grassroots strategies for HPV vaccination delivery

The birth of Savita (name changed) in Mandsaur district, Madhya Pradesh, 14 years ago was a moment of celebration for her family. The Banchhada community she was born into – a denotified tribe in Madhya Pradesh traditionally associated with sex work – welcomes the birth of girls, who are often viewed as future breadwinners. Yet, when a team of human papillomavirus (HPV) vaccinators recently approached Savita's family, they were apprehensive. "Will she be able to work?" they asked candidly, worried about the vaccine's future impact.

Their hesitation was neither unexpected nor isolated. Although cervical cancer is the second most common cancer among Indian women, preventive health-care initiatives often grapple with low levels of awareness and social stigma. Cervical cancer vaccination faces a distinct set of challenges – low cultural sensitivity around sexual health and gender bias, coupled with vaccine hesitancy – making it a pressing public health concern.

In light of this, the Government of India launched a nationwide cervical cancer campaign on February 28, 2026, providing free HPV vaccinations to 1.15 crore girls aged 14-15 years. India bears a quarter of the global cervical cancer burden, reporting over 1.2 lakh new cases and 80,000 deaths annually. Since nearly 95% of cases are caused by high-risk HPV strains, vaccination offers a significant preventive breakthrough.

From data to coverage

To implement the programme effectively and inclusively, the Mandsaur district administration adopted a data-driven, decentralised and adaptive strategy. For exhaustive coverage, the most vulnerable and often overlooked populations were targeted first.

Girls from difficult-to-reach communities – Banchhadas, nomadic tribes, urban slums, and school dropouts – became the starting point. These "missed populations" are at greater risk of falling off the radar of government service delivery.

At the grassroots, the challenge is often not vaccine hesitancy but data invisibility. Leveraging multiple government databases – Rashtriya Bal Swasthya Karyakram (RBSK), SAMAGRA MP (a citizen-centric social security platform by the Government of Madhya Pradesh) and Ladli Laxmi Yojana hyper-localised target lists were created. Fragmented records were transformed into actionable intelligence. Door-to-door surveys and tracking through SAMAGRA IDs ensured that eligible girls did not fall through statistical gaps. School and anganwadi enrolment gaps over the years were meticulously analysed to prepare village-level Master Line Lists. Rapid identification of 'low-coverage/high-resistance' areas enabled coordinated micro-planning. Mapping vulnerable groups geographically also enabled customising communication strategies, tailored to cultural sensitivities.

Reducing barriers through 'nudges'

Behavioural insights played a pivotal role in grassroots' saturation. The district relied on the "Nudge Approach" that helped design an environment where vaccination became the default choice. This helped in effectively breaking down grassroots barriers such as reluctance, inertia, social discomfort. Health-care workers informed families that their daughters were 'due for vaccination', rather than asking them to choose to vaccinate. Families who refused vaccinations received repeated counselling visits by health-care teams. Schools and local bodies arranged transportation to eliminate logistical barriers, simplifying access.

Misinformation hoaxes and myths around vaccine-induced infertility resulted in initial resistance. To counter rumours, the administration launched targeted awareness campaigns involving Gen-Z influencers and youth icons. National-level athletes, young doctors, students, religious leaders and media personalities voluntarily joined the effort to promote vaccination and dispel misconceptions.

Social norms and peer networks served as powerful "behavioural nudges". Local events publicly felicitated vaccinated families and recognised vaccinated girls as peer champions. Gram panchayat and ward-level data sharing sparked both collaboration and competition. Recognition was given to both top performers and the most improved. "Digital nudges" and red-flag reminders for frontline workers enhanced monitoring and accountability.

At the cutting-edge implementation level, resistance often manifests as delay, doubt, and discomfort rather than outright refusal. Vaccinations were conducted exclusively under medical supervision at visible health-care facilities, normalising the practice of adolescent girls' vaccination. Experiences of women affected by cervical cancer were shared to create emotional resonance and encourage informed decision-making. Counselling sessions reduced stigma and replaced distrust with dialogue.

Strategy to impact

The HPV campaign was further integrated with on-going health-care programmes. Routine immunisation days, antenatal care clinics and the Pradhan Mantri Surakshit Matritva Abhiyan sessions were used to promote HPV awareness and conduct vaccination drives. When women accessed one service, they became more receptive to another, creating avenues for 'bundling' of health-care service delivery.

The results were significant. In less than 40 days, Mandsaur achieved 100% of its vaccination target – 493 vaccination sessions were conducted through 12 permanent and 27 temporary vaccination sites across the district. Girls who met the criteria, from 893 villages and 190 urban wards, were mobilised, moving from planning on paper to protecting the population.

The magnitude of India's health-care challenge must be met with the measure of its grassroots' actions. Policy design must bridge the yawning gap between intended outcomes and empirical ground realities. Behavioural and systemic "nudges" in implementation can leverage the human tendency to opt for preset choices. Dovetailing health-care data and grassroots innovations tailored to regional realities can bridge the last mile and deliver the final dose.

By moving from coverage to care, from data to impact, Mandsaur turned a formidable public health challenge into a collective mass movement. The district's inclusive vaccination campaign demonstrated how a simple shot in the arm can truly become a fair shot at life.

Sanskriti IAS

GS 3: ENVIRONMENT
INDIAN EXPRESS PAGE: 10

Air pollution plan needs political will, not an eye on the election cycle

GUFRAN BEIG

OVER THE past few years, we have witnessed a troubling disconnect between scientific evidence and policy implementation in the country. First, the weak enforcement of the fuel-ban policy for end-of-life vehicles undermined its intended impact. Then, the draft Electric Vehicles (EV) Policy 2.0 raised serious concerns among environmentalists by proposing to extend EV incentives to hybrid vehicles. While hybrids combine petrol engines with electric motors, they remain dependent on fossil fuels and cannot deliver the full environmental and public-health benefits of zero-emission mobility.

Against this backdrop, the Delhi government's latest initiative marks a step in the right direction by targeting emissions at their source rather than targeting the open sky. It offers renewed hope for sustained improvements in air quality. The push for the EV policy 2.0 might shrink the urban carbon footprint, and the purification of local air could help alleviate concerns over respiratory and other non-communicable diseases that affect a substantial section of the city's population. For the metropolis, which juggles a staggering fleet of over 15 million vehicles, transitioning to electric mobility is no longer just an environmental aspiration; it is a public health imperative.

The Delhi emission inventory database in the National Institute of Advanced Study's (NIAS) 2025 policy brief reveals that the transport sector accounted for 41 per cent of the city's most deadly air pollutant, PM 2.5, in 2024. The new policy will unfold in two phases. Starting January 1, 2027, the city will completely halt the registration of conventional three-wheelers and light goods vehicles, permitting only electric models. From April 1, 2028, only electric two-wheelers will be allowed to register.

Two-wheelers contribute 20 per cent, whereas three-wheelers contribute less than 5 per cent of transport emissions. Currently, almost half of the three-wheelers are already non-fossil fuel, so their contribution is not 17-20 per cent as estimated by earlier studies, including the one by TERI in 2018. So, the overall gain with 100 per cent EV conversion of these three categories of vehicles would be 35 per cent of total transport, which will translate to just 15 per cent of Delhi's PM 2.5 concentration — this is a good initiative, but it won't lead to drastic improvement.

However, a balanced perspective is one of the fundamental requirements of science. Studies conducted by the NIAS show that this policy is merely the first battle in a much larger war. While the present policy is a good start, to truly clear the air, subsequent policies must tackle the two heaviest polluters: Heavy commercial vehicles and buses, which command around 60 per cent of transport emissions. Tackling pollution from their tailpipes could reduce Delhi's PM 2.5 by 20-25 per cent.

The number of commercial vehicles and buses might be low, but their emissions are higher compared to those from two-wheelers and cars. Policymakers need to prioritise targets based on the most polluting fleet. Transforming commercial vehicles to EVs will yield the maximum benefit. However, practical challenges need to be assessed.

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The public-health payoffs of this structural shift are monumental. According to an NIAS policy brief, adoption of EVs would avert 800 premature deaths annually because cleaner air would reduce diseases linked to vehicle emissions, such as heart disease, stroke, lung cancer, and respiratory illnesses. It will save 12,000 years lost to disability every year. In other words, Delhi's population would collectively gain the equivalent of 12,000 additional healthy years of life every year through reduced illness and premature death. Beyond the intrinsic value of human life, this transition makes undeniable economic sense. According to the NIAS study in 2025, transitioning two-wheelers, three-wheelers, and light commercial vehicles fully to electric power could save at least Rs 1,000 crore every year in averted medical expenses, reduced hospital admissions, and recovered economic productivity. When weighed against the Delhi government's pledge to invest Rs 15,000 crore in the EV policy over the next four years, the return on investment becomes clear. The state's entire four-year financial commitment to subsidies and infrastructure is likely to be offset soon. However, this needs to be extended to other vehicle categories firmly to get early returns.

The success of the policy will require sustained investment. Its true environmental and physiological rewards will mature over years rather than months. Policymakers will need to stay the course and demonstrate political will. Air pollution does not recognise election cycles. For Delhi to witness a permanent transformation, these mandates must be agnostic to political shifts, and public health needs to be given top priority.

The government also needs to give serious thought to phasing out CNG. After all, its use all involves combustion and, therefore, pollution — especially of NOx. Such pollution needs to be curbed.

This is the time for deliberate, science-aligned, and phased policy-making (as underlined by the National Air Quality Resource Framework of India) — one that sets clear targets and ensures that interim measures do not undermine long-term goals. If we truly care about clean air, we must get the priorities and the timelines right. We understand that transport bears an enormous responsibility for pollution's stranglehold on our cities, and we have finally made a good start. Now, we must summon the courage and political will to leap to the ultimate solution, attack the source directly, rather than languish in the mediocrity of transitional technologies.

In a city gasping for every breath of clean air, our survival may well depend on the choices we make today.

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