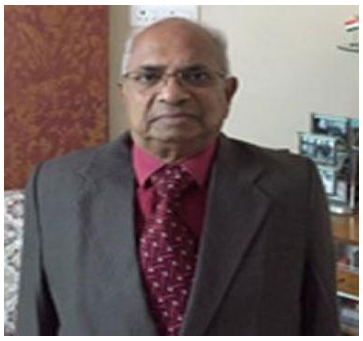
ISASBHARAT Newsletter

Vol 24, No.1 *Jan-March , 2024*

Message from President ISAS



My dear ISAS friends,

Hearty greetings!

I am highly delighted to have the first quarterly (January- March) e-issue of the ISAS News Letter of the year 2024. The news letter intends to cover mainly events conducted by ISAS throughout the period besides the prime developments occurring in scientific aura.

International Analytical Science Congress IASC 2024 was organized with the focal theme: Analytical Sciences and Technologies: Futuristic Trends- for Energy, Environment and Sustainable Development (AST: FT- EESD) during February 22-24,

2024. The event was organized at VNIT, Nagpur, on 22nd and 23rd and on 24th at JNARDDC, Nagpur. The event was collaborated by JNARDDC and co-organized by VNIT, and RKNEC, and ISAS Nagpur chapter, Nagpur. The congress was graced by Mr. P Mukherjee, CEO, BRIT as Chief Guest and Mr B Sarvanan, Director AMD as Guest of Honour. Their gracious presence put the congress in higher orbit and added a distinguished aura to the congress.

The other dignitaries gracing the congress included Dr P Agnihotri Director, JNARDDC, Professor PM Padole, Director, VNIT, and Dr Rajesh Pande, Principal, RKNEC.

During the congress, Life Time Achievement, Shastra Pitamah, aatmanirbharta, Homi Bhabha, M. Sunderesan and several other awards besides ISAS fellowship were conferred to Scientists of distinguished caliber with appreciable contribution to respective fields (For Details please visit isasbharat.in)

The souvenir published contained two keynote addresses, 34 invited talks (IT) and about 115 research papers presented orally and in poster session. The salient features derived out of the congress would be reported and recommended to Neeti Aayog for considering implementation of the points. ISAS Vadodara has offered to conduct the IASC next year in 2025. ISAS Belagavi chapter has expressed its intention to conduct the congress in the subsequent year. Both the events would be in collaboration with HQ, ISAS.

Besides, Delhi Chapter, Pune Chapter and Belagavi Chapter are actively involved in several activities (details furnished in official WhatsApp group EC ISAS 31.03.2023 onwards to be loaded on isasbharat.in). Kerala Chapter has already prepared its newsletter and is going to be loaded shortly.

ISAS intends to employ the oceans of research and studies generated in analytical sciences and technology to create substantive transformative impact on sustainable development of the common populace in lieue of purely academic outcome. On the contrary the research should be more dedicated and purpose driven to deliver quality outcomes on an exponential scale.

With best wishes to you all !

Dr. Raghaw Saran
Ph.D, FIC, FICS,F ISAS, LM IANCAS,
LM REAI,
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From Editor's Desk

Happy Holi to all ISAS Members

It gives me immense pleasure to bring out the first issue of the year 2024. This period has been full of vigorous activities. The IASC-2024 conference was conducted at VNIT Nagpur during 22-24 Feb, 2024. Eminent speakers from India and abroad delivered scientific talks. Congratulations to Dr. Raghaw Saran, President ISAS and organizing team.

A large number of significant scientific events have taken place in nuclear and space. Nuclear energy assumes significance in the context of achieving net-zero carbon dioxide emission. Prime minister has appreciated the contribution of the nuclear industry towards country's development. Modi ji witnessed commencement of core loading at India’s first indigenous Prototype Fast Breeder Reactor (500 MWe) at Kalpakkam on March 4, 2024. A matter of prestigious pride for India, becoming the second country in the world, after Russia, capable of operating Fast Breeder Reactors. DAE is progressing significantly in supply of electricity, indigenously developing PHWRs of 700 MW. Modi ji dedicated Kakarapar Atomic Power Station (KAPS-3&4) to the nation in Surat on Feb 23, 2024. Prime minister dedicated Demonstration Fuel Reprocessing Plant (DFRP) to the nation at the Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam in chengalpattu district.

ISRO is progressing marvelously, touching new- new heights. Prime Minister Modi ji gave the astronauts wings and revealed the Gaganyaan Mission astronauts to the world viz. Group Captain Prashanth Balakrishnan, Group Captain Ajith Krishnan, Group Captain Angad Pratap, Wing Commader Shubhanshu Shukla. India's X-ray polarimeter satellite (XPoSat), India's black hole observatory, has successfully captured its inaugural light from the Cassiopeia A (Cas A) supernova remnant. Another historical day for India, India's Sun mission, Aditya-L1 entered its final orbit. Aditya-L1 is first space-based indian observatory to study the sun nearly 1.5 million kilometre away from the earth. Atom for space; ISRO in collaboration with BARC has initiated work on nuclear engines for upcoming space missions.

Bharat Petroleum Corporation (BPCL), at the India Energy Week 2024 in Goa. demonstrated India‘s first indigenous alkaline electrolyser to Prime Minister. The

electrolyser is collaboratively developed by BPCL and BARC. Renowned nuclear scientist Dr. Anil Kakodkar, former Chairman of the Atomic Energy Commission, has been honored with a lifetime achievement award by the Army Institute of Technology. NASA wraps up the first phase of an ambitious reactor project of nuclear power on the Moon. The Indian Institute of Technology, Mandi, is developing a first-of-its-kind indigenous room-temperature quantum computer based on photon use for faster calculation. Computers can suggest solutions with 86 % accuracy without traditional algorithms. ISRO has taken a giant leap forward in its pursuit of deep-space exploration missions to distant celestial bodies. Nuclear propulsion is ideally suited for long-duration, deep-space missions, as they can generate paramount thrust with minimal nuclear fuel consumption. NASA's James Webb space telescope captured cosmic christmas tree's shining in space. The cluster, known as NGC 2264, in Milky Way galaxy, is about 2,500 light-year distant from earth. NASA's Voyager-1, launched in 1977, currently 15 billion miles away, is surprisingly still working, sending signals. However, it is now glitching, sending nonsensical messages. Signal receiving time is around 22 hour. For the first time, at University of Technology Sydney's scientists have created a portable device capable of writing THOUGHTS. Atomic batteries or Radioisotope Thermoelectric Generators (RTGs), are going to play crucial role in space exploration, medical implants and devices, defense and security systems, environmental monitoring and research. Atomic batteries use energy or heat generated from decay or radioisotopes such as Plutonium-238 or Strontium-90. Atomic batteries are compact, reliable sources, having long lives.

Scientists have taken a groundbreaking step by connecting clusters of human brain cells grown in the lab ("brain organoids") to computer chips, enabling recognizing of spoken words. The World Health Organization (WHO) has

recognized loneliness as a serious global health threat, as deadly as smoking 15 cigarettes a day. Scientists have discovered a strong connection between regular exercise and the size of crucial brain regions linked to memory and learning.

Much of love can be explained by chemistry. For centuries, people believed that love arose from the heart. At present, love is all about the brain which, in turn, makes the rest of your body go haywire. Love has three categories: lust, attraction, and attachment. Testosterone and estrogen drive lust; dopamine, norepinephrine, and serotonin create attraction; and oxytocin and vasopressin mediate attachment.
Good news for tea lovers, according to a study, drinking three cups of tea a day could slow down aging. A team of scientists from Japan has made an incredible discovery, capturing real-time footage of plants "talking" to each other.

Jai Vigyan

Jai Bharat

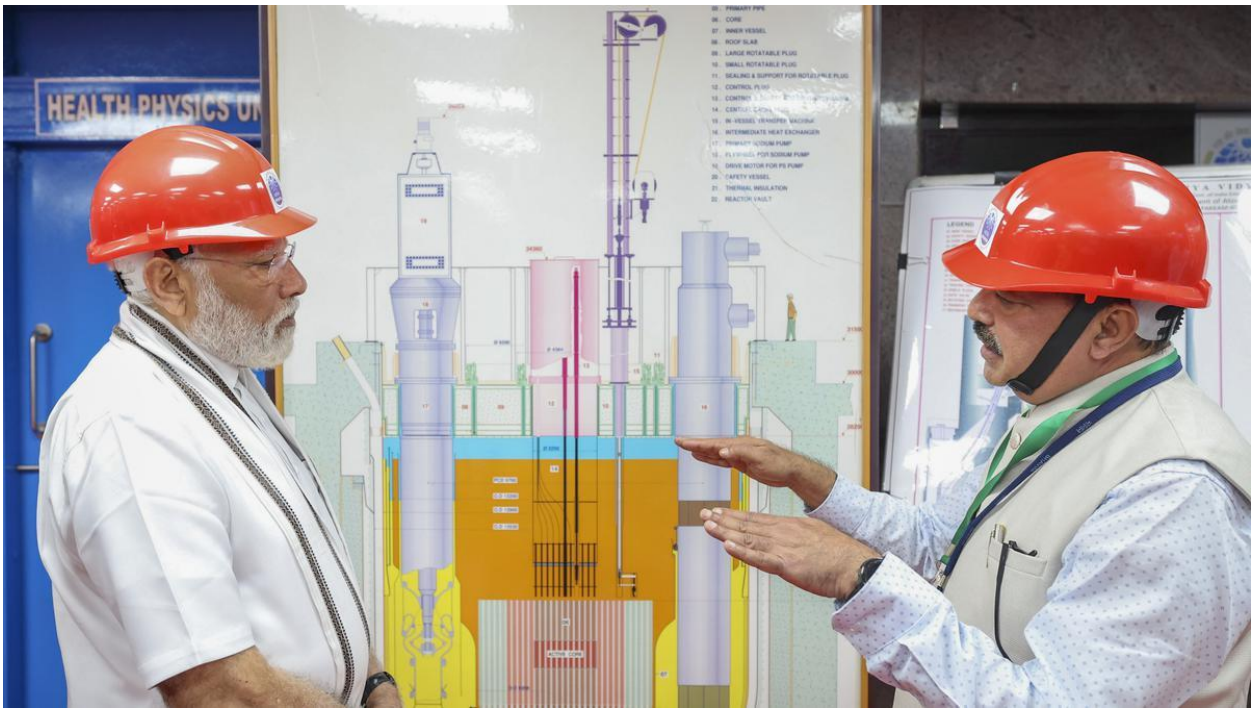
Dr. Pradeep Kumar

Chief Editor, ISAS Newsletter

PM Modi witnesses commencement of core loading at India’s first indigenous Fast Breeder Reactor at Kalpakkam

The reactor has been fully designed and constructed indigenously with significant contribution from more than 200 Indian industries including MSMEs

March 04, 2024 08:22 pm | Updated 08:25 pm IST - CHENNAI, The Hindu Bureau



Prime Minister Narendra Modi witnesses initiation of core loading of India’s indigenous Prototype Fast Breeder Reactor, at Kalpakkam in Tamil Nadu on March 4, 2024. | Photo Credit: PTI

Prime Minister Narendra Modi on Monday witnessed commencement of “core loading” at India’s first indigenous Fast Breeder Reactor (500 MWe) at kalpakkam, situated about 70 km from here. He also took a tour of the reactor vault and the control room of the reactor and was briefed about its salient features. India has developed comprehensive capabilities spanning the entire spectrum of the nuclear fuel cycle. The government had approved in 2003, the creation of Bhartiya Nabhikiya Vidyut Nigam Ltd., (BHAVINI) to construct and operate India’s most

advanced nuclear reactor-Prototype Fast Breeder Reactor (PFBR), according to a statement.

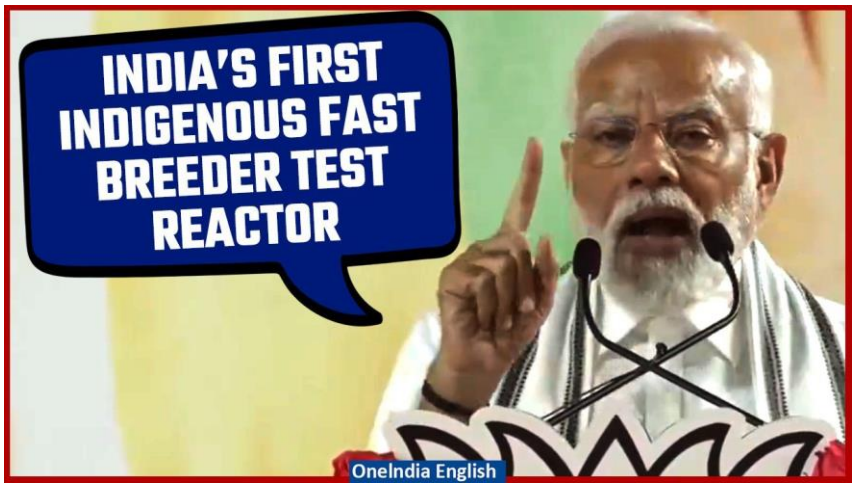
The PFBR has been fully designed and constructed indigenously by BHAVINI with significant contributions from more than 200 Indian industries including MSMEs. Once commissioned, India will only be the second country after Russia to have commercial operating Fast Breeder Reactor, it added.

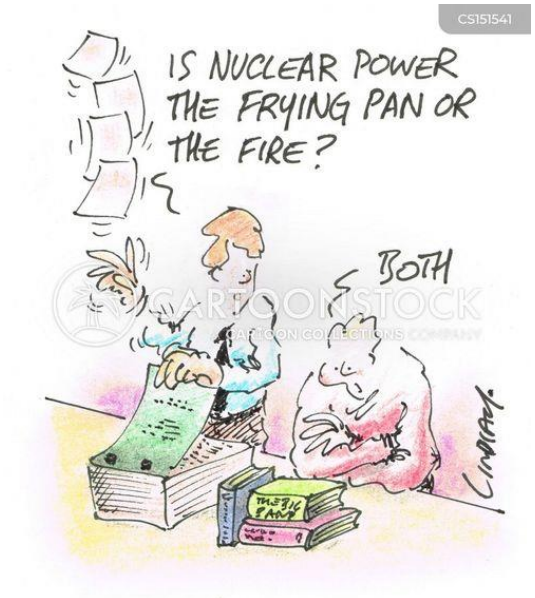
In terms of safety, the PFBR is an advanced third generation reactor with inherent passive safety features ensuring prompt and safe shutdown of the plant in the event of emergency, the official statement said. Since it uses the spent fuel from the first stage, FBR also offers great advantage in terms of significant reduction in nuclear waste generated, thereby avoiding the need for large geological disposal facilities, it added.

Upon completion of the core loading, the first approach to criticality will be achieved, leading to generation of power subsequently. Despite the advanced

technology involved, both the capital cost and the per unit electricity cost is comparable to other nuclear and conventional power plants, the statement said.

The growth of the Indian nuclear power programme is imperative to meet the twin goals of energy security and sustainable development. As a responsible nuclear power with advanced technology, India remains committed to expand peaceful applications of nuclear technology, both in power and non-power sector, while ensuring the security of nuclear and radiological materials, it added.





PM Dedicates to Nation Two Reactors at Kakrapar Atomic Power Station in Surat

23 February, 2024 | by PTI

After addressing a gathering at Navsari in south Gujarat, the PM reached Kakrapar village of adjoining Surat district where the nuclear power plant is situated.

Prime Minister Narendra Modi on Thursday dedicated to the nation two new Pressurised Heavy Water Reactors (PHWRs) with a cumulative capacity of 1,400 megawatt established at Kakrapar Atomic Power Station (KAPS) in Gujarat's Surat district. After addressing a gathering at Navsari in south Gujarat, the PM reached Kakrapar village of adjoining Surat district where the nuclear power plant is situated. The new Unit 3 and Unit 4 at KAPS, each having capacity to produce 700 MW of electricity, were built by the Nuclear Power Corporation of India Ltd (NPCIL) at a cost of over Rs 22,500 crore and they are the largest indigenous PHWRs in the country, officials said. During his visit to the atomic power station in the evening, the PM inaugurated the two new reactors and also interacted with senior officials, including NPCIL Chairman and Managing Director Bhuwan Chandra Pathak.

The PM was accompanied by Gujarat Chief Minister Bhupendra Patel and BJP Member of Parliament from Navsari CR Paatil, who is also the president of the ruling party's state unit. Modi visited the main control room of the power plant and understood different processes and other finer details from Pathak. Before leaving KAPS, the PM briefly addressed scientists and as well as senior officers at the plant and motivated them to continue their good work, the officials said. On Wednesday, a PIB release said these two units are first of its kind reactors and have advanced safety features comparable with the best in the world. Together, these two reactors will produce about 10.4 billion units of clean electricity per year and benefit consumers of multiple states like Gujarat, Maharashtra, MP,

Chhattisgarh, Goa and Union Territory of Dadra and Nagar Haveli and Daman and Diu, the release said.

The PM began his Gujarat visit in the morning by attending golden jubilee celebrations of Gujarat Cooperative Milk Marketing Federation (GCMMF), which sells dairy products under the Amul brand, at the Narendra Modi Stadium in the Motera area of Ahmedabad city. Later, he visited Tarabh village in Mehsana district and then Navsari district, where he addressed gatherings after inaugurating as well as laying foundation stones of various development projects.

Source website link: https://energy.economictimes.indiatimes.com/news/power/pm-dedicates-to-nation-two-reactors-at-kakrapar-atomic-powerstation-in-surat/107928825

The third and fourth nuclear reactors with their containment domes (extreme left) at Kakrapar in Surat, Gujarat. Their cooling towers are visible. | Photo Credit: NPCIL

Indian PM Dedicates Demonstration Fuel Reprocessing Plant to Nation

10 January, 2024 | by neimagazine.com

Source website link: https://www.neimagazine.com/news/newsindian-pm-dedicates-demonstration-fuel-reprocessing-plant-to-nation-11425550

Indian Prime Minister Narendra Modi has dedicated to the nation the Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP) at the Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam in Chengalpattu district. The DFPR was built at a cost of about INR4bn ($48m) and is the world's only industrial-scale plant capable of handling both carbide and oxide used fuels from fast reactors, according to an official statement.

The project was dedicated to the nation in a recent ceremony attended by India's Prime Minister Shri Narendra Modi (courtesy of DAE India)

The DFRP houses indigenously designed and developed novel equipment and symbolises the successful collaboration between government R&D infrastructure and Indian industries, providing a crucial stepping stone for the next generation of breeder and fast reactors, the statement said.

"The dedication to the nation of DFRP by Prime Minister Narendra Modi underscores India's commitment to realising the dream of Net Zero by leveraging the full potential of India's uranium and thorium reserves and providing abundant green energy through the three stage nuclear power programme," it added. The new facility is a significant step towards advancing India’s nuclear capabilities and is designed to reprocess fuel from Prototype Fast Breeder Reactors (PFBR). The fast reactor power generation company, Bharatiya Nabhikiya Vidyut Nigam Ltd (BHAVINI), based in Kalpakkam, played a leading role in this initiative. BHAVINI is currently setting up the PFBR and has plans for two additional fast reactors in the future. The DFRP is a pilot project for larger facilities.

The Department of Atomic Energy (DAE) highlights the DFRP as a crucial step towards the establishment of large commercial-scale fast reactor fuel reprocessing plants supporting India's commitment to achieving self-sufficiency in nuclear fuel cycle capabilities. The integrated commissioning of the PFBR, managed by BHAVINI, is well underway. Significant milestones include the filling of the main vessel with 1.15 tonnes of liquid sodium in August 2023 and the deployment of indigenously manufactured primary and secondary sodium pumps.

Adjacent to Kalpakkam, the Fast Reactor Fuel Cycle Facility (FRFCF) is under and is anticipated to be completed by December 2027. This ambitious project, executed by the Nuclear Recycle Board, the Bhabha Atomic Research Centre (BARC), and the DAE, was originally budgeted at approximately INR 96bn. The primary goal of the FRFCF is to reprocess used fuel from fast breeder reactors. In 2017, IGCAR awarded Hindustan Construction Company a contract worth INR7.64bn to construct the FRFCF.

Fast breeder reactors (FBRs) are key to India's three-stage nuclear power programme, which is intended to exploit India's vast resources of thorium. DAE envisioned the introduction of plutonium fuelled fast reactors as the intermediate stage, between pressurised heavy water reactors and thorium-uranium-233 based reactors. This necessitated closing the fast reactor fuel cycle. DAE therefore set up special R&D facilities for fast reactor fuel reprocessing at IGCAR (phase one) and pilot plant CORAL, was commissioned in 2003 (phase two). The third phase is the construction and operation DFRP. In the fourth phase, commercial scale reprocessing will be carried out by setting up the reprocessing plant (FRP), which will close the PFBR fuel cycle.

India Reveals Gaganyaan Crew, PM Modi's Standing Ovation

The four astronauts are Group Captain Prashanth Balakrishnan, Group Captain Ajith Krishnan, Group Captain Angad Pratap, Wing Commader Shubhanshu Shukla. In Short

- Prime Minister Modi reviewed the progress of the Gaganyaan mission
- Gaganyaan mission aims to carry a crew of three astronauts into low Earth orbit
- The selection and training of astronauts for the Gaganyaan mission have been rigorous

The four astronauts have undergone extensive training at Russia and the program is now underway in India at Isro training facility. (Photo: PIB)

Prime Minister Narendra Modi on Tuesday gave the astronauts wings and revealed Gaganyaan Mission astronauts to the world. The four Indian Air Force Officers will be the first Indians to go to space from Indian soil on an indigenous space vehicle. The four astronauts are Group Captain Prashanth Balakrishnan, Group

Captain Ajith Krishnan, Group Captain Angad Pratap, Wing Commader Shubhanshu Shukla. The four astronauts have undergone extensive training at Russia and the program is now underway in India at ISRO training facility.

PM Modi gave astronaut wings to the four Indian astronauts. (Photo: PIB)

Prime Minister Narendra Modi gave a standing ovation to the four astronauts and said, "We are witnessing another historic journey at Vikram Sarabhai Space Centre. India meets its four Gaganyaan astronauts. These are not just four names, but forces that will take the aspirations of 140 crore Indians to space." Prime Minister Modi reviewed the progress of the Gaganyaan mission at the VSSC and interacted with Vyomitra, a humanoid, that will be the first to launch on the Gaganyaan Mission before astronauts set foot in the crew capsule.

XPoSat: ISRO's black hole observatory looks at exploded star: Cassiopeia A

This achievement marks a crucial step in India's first X-ray polarimetric mission since its launch on January 1.

In Short

The XPoSat mission is equipped with two sophisticated instruments

The XSPECT payload, in particular, has been instrumental in observing Cas A

The XPoSat mission promises to be a game-changer in X-ray astronomy

India's X-ray Polarimeter Satellite (XPoSat) has successfully captured its inaugural light from the Cassiopeia A (Cas A) supernova remnant. This achievement marks a crucial step in India's first X-ray polarimetric mission since its launch on January 1.The XPoSat mission is equipped with two sophisticated instruments, the POLarimeter Instrument in X-rays (POLIX) and the X-ray SPECtroscopy and Timing (XSPECT), both designed to probe the enigmatic nature of cosmic X-ray sources.

The XSPECT payload, in particular, has been instrumental in observing Cas A, a well-known celestial calibration source. Commencing on January 5, XSPECT's observation campaign has yielded valuable data, capturing emission lines from various elements such as Magnesium, Silicon, Sulphur, Argon, Calcium, and Iron. These observations are pivotal for calibrating the instrument and validating its performance.

XPoSAT will help study the radiation from near black holes and neutron stars.

We'd like two minutes of your time in order to understand you better. Please take this reader survey. Developed by the Space Astronomy Group at the U R Rao Satellite Centre (URSC) under the Indian Space Research Organisation (ISRO) in Bengaluru, XSPECT's capabilities extend to continuous and long-term spectral and temporal studies of X-ray sources within the soft X-ray band. Its design allows for uninterrupted observations, which are expected to enhance our comprehension of high-energy phenomena in the universe.

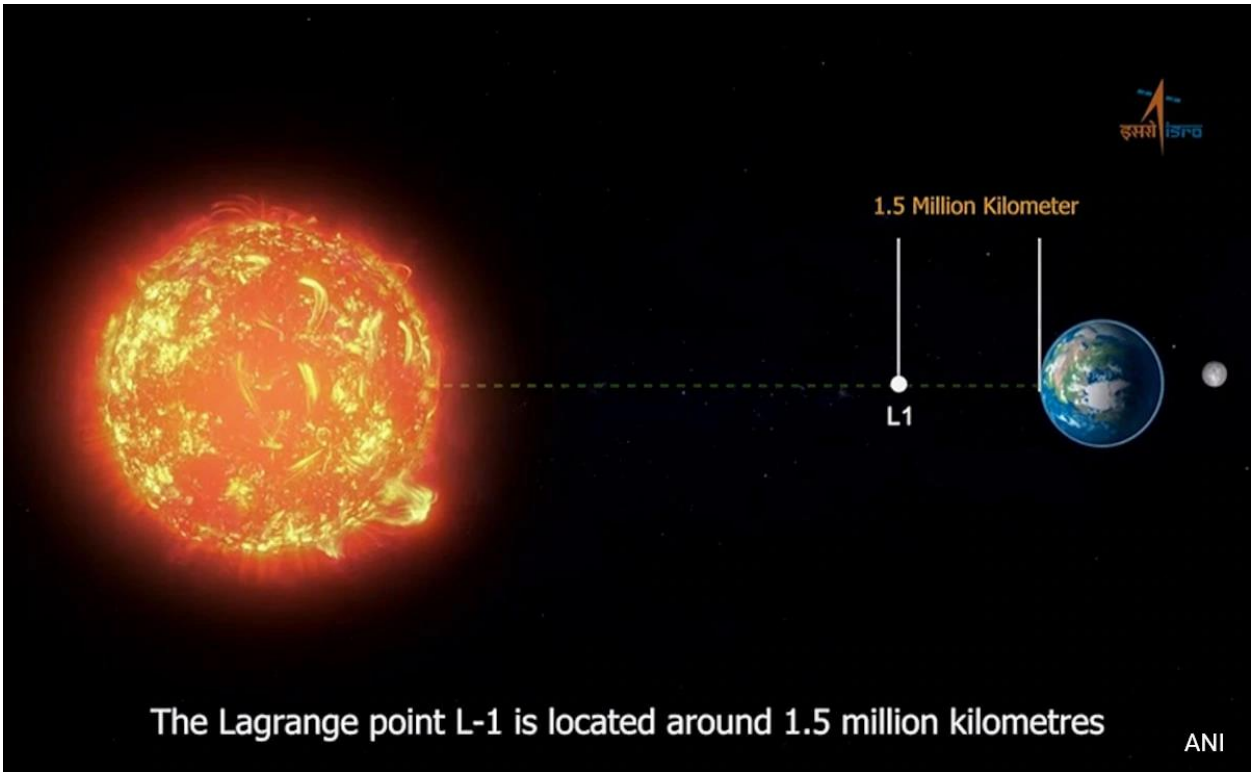
The POLIX instrument complements XSPECT by focusing on the medium-energy X-ray band, specifically investigating the polarization of X-rays. Together, these instruments aim to provide a more comprehensive understanding of the physical processes occurring in extreme environments, such as those surrounding black holes, neutron stars, and supernova remnants.

The XPoSat mission, with an anticipated **lifespan of five years,** promises to be a game-changer in X-ray astronomy. By enabling X-ray polarimetry measurements in the medium energy band, a range previously unexplored, XPoSat stands to enhance our knowledge of the cosmos.

Published By:Sibu Kumar Tripathi Published On: Jan 11, 2024

Big Day For India's Sun Mission, Aditya-L1 To Enter Final Orbit Today

Built at a cost of Rd 400 crore, the nearly 1,500 kg satellite will function as the first space-based Indian observatory to study the sun nearly 1.5 million kilometres from the Earth



Indian Space Research Organisation's Aditya-L1, India's first mission to study the sun, is set to reach its final destination orbit on Saturday, over four months after it began its ambitious journey from ISRO's Sriharikota launchpad. Built at a cost of Rsd 400 crore, the nearly 1,500 kg satellite will function as the first space-based Indian observatory to study the sun nearly 1.5 million kilometres from the Earth.

The satellite is expected to be placed in a halo orbit around Lagrange point 1 (L1) at around 4 pm. The final insertion point was chosen for its advantageous position which remains unhindered by eclipses and can be used to view the Sun continuously. This manoeuvre (at around 4 pm on Saturday) will bind the Aditya-L1 to a halo orbit around L1. If we don't do this, there is a possibility that it will continue its journey, maybe towards the Sun," an ISRO official told news agency PTI. The space observatory will keep an eye on the changing space weather and warn scientists about unfavourable changes including solar storms and flares that may impact the working of satellites. A solar storm is a large-scale magnetic eruption on the Sun, which can effect the entire solar system."Since Aditya-L1 will look at Sun continuously, it can warn us of imminent solar electro-magnetic effects on Earth and protect our satellites, and other power electrical and communications networks from getting disrupted. This will help continue normal operations by operating them in safe modes, till the solar storm passes by," ISRO Chairman S Somanath had told NDTV. Mr Somnath said that India has assets worth over 50,000 crores in space including over 50 operational satellites that need to be protected against the wrath of the Sun.

The Aditya-L1 satellite, carrying seven payloads, will also conduct scientific experiments to better understand the photosphere, chromosphere and the outermost layers of the Sun (the corona) using electromagnetic, particle and magnetic field detectors. Apart from the less-studied solar weather, the satellite will gain crucial information about pre-flare and flare activities and the dynamics of space weather.

According to ISRO, these are the major scientific objectives of Aditya-L1 mission:

Study solar upper atmospheric (chromosphere and corona) dynamics. Study chromospheric and coronal heating, the physics of the partially ionized. Plasma, the initiation of the coronal mass ejections, and flares. Observe the in-situ particle

and plasma environment, providing data for the study of particle dynamics from the Sun. Study the physics of solar corona and its heating mechanism.

Diagnostics of the coronal and coronal loops plasma: Temperature, velocity and density. Development, dynamics and origin of CME (Coronal Mass Ejections). Identify the sequence of processes that occur at multiple layers (chromosphere, base and extended corona) which eventually leads to solar eruptive events . Magnetic field topology and magnetic field measurements in the solar corona. The origin, composition and dynamics of solar wind, the drivers for space weather

Atom for Space: Nuclear Propulsion for Interstellar Navigation

16 February, 2024 | by Dr Sitakanta Mishra

ISRO in collaboration with BARC has begun work on nuclear engines for its upcoming space missions

Outer space is fast becoming the new economic and strategic high ground. During the last few decades, prominent countries have ventured into outer space and many of them dream of interplanetary missions. However, the biggest challenge for interstellar travel is the availability of reliable power sources for spacecraft propulsion, and on-board spaceship systems in the harsh environment of space. The great astronomer Carl Sagan once said that "one cannot travel fast into space without travelling fast into the future;" truly, without futuristic energy sources and propulsion technology, deep-space exploration would not be feasible. Radioisotope and nuclear-based propulsion technology is the promising gateway to outer space.

Today, spacecraft propulsion, power for on-board spaceship systems, and energy generation in extra-terrestrial voyages are mainly based on chemical and solar energy. But long-term space missions such as establishing and maintaining space stations, lunar bases, Mars missions, deep-space exploration, or

interplanetary missions require huge and uninterrupted power supply. For such missions, nuclear fusion propulsion is the next-generation energy solution as the atom is a source of high energy density and inexhaustible.

Technically, there are three possible key nuclear technologies for space propulsion: (1) Nuclear Pulse Propulsion (NPP) used for shorter trips with high acceleration but with lower propellant efficiency [currently not in use]; (2) Nuclear Thermal Propulsion (NTP); and (3) Radioisotope Electric Propulsion (REP). NTP uses a fission reactor to heat a liquid propellant: the heat converts the liquid propellant into gas, which expands through a nozzle to provide thrust to propel the spacecraft. With REP, the thrust is produced by converting the thermal energy from a nuclear reactor into electrical energy. Currently, space programs are using the eighth generation of nuclear batteries called the Multi-Mission Radioisotope Thermoelectric Generator or MMRTG.

Interstellar or interplanetary voyages have long been a matter of science fiction, but it would not be far from a reality soon given the growing interest and research in harnessing nuclear technology for space application. Many countries today have deep-space exploration programs with nuclear propulsion technology experiments. Nuclear pulse propulsion was first developed as Project Orion by the Defense Advanced Research Projects Agency (DARPA), U.S. Department of Defense, in 1947. Between 1955 and 1972, the United States spent more than $1.4 billion on developing nuclear rockets and related technologies.

So far, NASA has only sent one nuclear reactor to space, on a satellite in 1965. Since 1965, the United States has been using only Radioisotope Thermoelectric Generators (RTGs) in space exploration and not nuclear reactors. The high decay heat of Plutonium-238 or Strontium-90 enables its use as an electricity source in the RTGs of spacecraft. So far over 45 RTGs have powered 25

US space vehicles including Apollo, Pioneer, Viking, Voyager, Galileo, Ulysses, Cassini and New Horizons space missions, as well as many civil and military satellites. NASA's Mars rover was equipped with nuclear power induced technology, which allowed its detectors to analyze the composition of Martian rocks. Also, NASA aims to test a 40-kilowatt microreactor on the moon by 2030.

Project Daedalus was a study conducted between 1973 and 1978 by the British Interplanetary Society (BIS) to design a plausible interstellar spacecraft that could reach Alpha Centauri in more than four decades. A year ago the UK Space Agency (UKSA) awarded funding to the rocket company Pulsar Fusion to develop nuclear fission-based power systems. Meanwhile, the European Space Agency (ESA) is funding several studies such as the Rocket Roll that will explore the use of nuclear propulsion for deep space exploration.

The former USSR had a long history of successfully deploying "33 military reconnaissance and targeting spacecraft with nuclear reactors into low-Earth orbit from 1969 to 1988." In the post-Soviet era, Russia renewed its interest in the space application of nuclear energy, not only for propulsion systems but also for other equipment aboard large spacecraft for military requirements. The KB Arsenal design bureau, the prime contractor in Russia's military spacecraft project, is known for its Soviet-era nuclear-powered satellites.

Reportedly, Russian space agency Roscosmos is considering using the Zevs (Zeus) nuclear tug by 2030 to propel heavy cargo through deep space (Nuklon project) estimated at more than 4.17 billion rubles – to the Moon, then Venus and Jupiter, and also clean up space debris. The scheduled space tug, featuring a 500-kilowatt nuclear reactor and weighing up to 22 tons, will first fly to the Moon, where it will release a spacecraft that will go on to Venus, and "then use Venus as a gravity assist to deliver yet another spacecraft, which will make its long journey

to Jupiter." The "Zeus" module would advance those efforts by using a 500-kilowatt nuclear reactor to propel inter-planetary missions.

So far, Russia has flown more than 30 fission reactors in space. Its independent efforts in space nuclear power systems traced back to 1998, and during the presidency of Dmitry Medvedev, these efforts were proclaimed among the Kremlin's key priorities. Russia continues a special nuclear space programme "Through the Atom to the Stars" and Rosatom has played a crucial role ever since. Its expertise and technology could aid Moscow to develop a new space station by 2025.Today Russia, a leader in the global nuclear space race, is much ahead of all others.

China is aggressively investing and working on a wide range of space technologies including nuclear propulsion designs to speed travel times in outer space, and to protect its various "cislunar" assets. Mainly China has relied on Russia for radioisotope units for its Chang'e-3 and 4 lunar lander and rover missions, including an RTG for Yutu-2. However, China is now exploring breakthroughs and has proposals for indigenous reactors in its space missions, including the uranium-powered ACMIR.

India, on the other hand, is no way behind in the unfolding nuclear propelled space race. The Chandrayaan-3 propulsion module orbiting the Moon is powered by nuclear technology. After its success, ISRO in collaboration with BARC has begun work on nuclear engines for its upcoming space missions. On January 28, 2021, ISRO's UR Rao Satellite Centre issued a call for proposals outlining a three-phase plan to create a 100-watt RTG.

Gradually peaceful uses of atomic propulsion for space exploration are gaining momentum. To overcome the limitations of spacecraft speed and power demand for deep-space voyages, nuclear is undoubtedly the next space frontier.

First, nuclear-based propulsion could speed up space travel ten times faster than light. Second, if harnessed for propulsion, nuclear fusion could revolutionize interstellar travel by providing a nearly limitless supply of energy, efficiency and cost-effectiveness. Third, the space flights would need to lift less fuel and reduce trip times.

With this type of propulsion technology, the thrust may be lower but continuous, and the fuel efficiency is far greater, resulting in a higher speed and potentially over 60% reduction in transit time to Mars compared to traditional chemical rockets. Moreover, reduced time in space would also reduce the exposure of astronauts to cosmic radiation.

From all counts, the world is entering a new age of 'space geopolitics' and the "pathway to the stars runs through the atom", rightly says Michail Chudakov, head of the Department of Nuclear Energy at IAEA. Spaceborne fission would enable a single spacecraft to explore multiple targets in the outer solar system and even beyond which humans have always remained fascinated. Nuclear energy has the potential to fulfil this dream; it is just a matter of time and with the maturing of nuclear space technology, the sky won't be the limit for human beings.

Source website link: https://www.financialexpress.com/business/defence-atom-for-space-nuclear-propulsion-for-interstellar-navigation-

BPCL, BARC Showcase Indigenous Prototype Alkaline Electrolyser for Hydrogen Generation to Prime Minister Narendra Modi

07 February, 2024 | by Express Mobility Desk

BPCL strategically plans a 5 MW Green Hydrogen Plant at Bina Refinery. Additionally, a 500 KW capacity Integrated Hydrogen Refueling Station will be established at CIAL.

G. Krishnakumar, C&MD of BPCL showcasing the indigenously developed electrolyser to Prime Minister Narendra Modi.

Bharat Petroleum Corporation (BPCL), a leading player in the energy sector has marked a significant milestone today at the India Energy Week 2024 in Goa. The company showcased what it claims is India‘s first indigenous alkaline electrolyser to Prime Minister Narendra Modi. The electrolyser is collaboratively developed by BPCL and the Bhabha Atomic Research Centre (BARC). It uses alkaline water electrolysis, the process through which hydrogen is produced from alkaline water via electrolysis, marks a pivotal advancement in industrial-scale application. The technology demonstrates high cell efficiency and robustness in an alkaline environment.

In line with India‘s target to produce 5 million tons of green hydrogen by 2030, BPCL strategically plans a 5 MW Green Hydrogen Plant at Bina Refinery.

Additionally, a 500 KW capacity Integrated Hydrogen Refueling Station will be established at CIAL. This electrolyser underscores BPCL‘s commitment to India‘s pursuit of Energy Independence through initiatives such as _Aatma Nirbhar Bharat‘ and Vocal for Local‘.

By manufacturing this electrolyser locally, BPCL actively contributes to the nation‘s self-sufficiency in the energy sector. BPCL is showcasing its ongoing efforts in the IEW 2024 Hydrogen Pavilion, highlighting progress in green hydrogen production. This initiative aims to spotlight India‘s indigenous capabilities in the hydrogen domain, garnering significant interest from technocrats and industry stakeholders.

Source website link: https://www.financialexpress.com/business/express-mobility-bpcl-barc-showcase-indigenous-prototype-alkalineelectrolyser

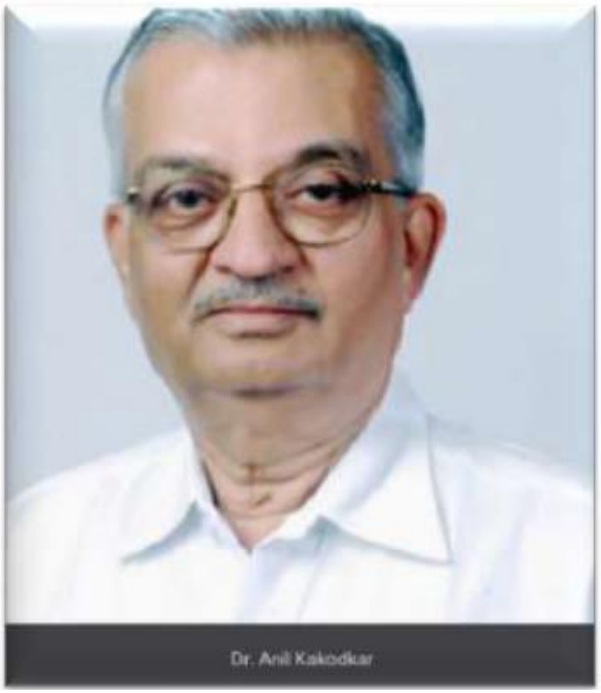
Renowned Nuclear Scientist Dr. Anil Kakodkar to be honored with a Lifetime Achievement Award by the Army Institute of Technology

18 February, 2024 | by PuneMirror Bureau

The Army Institute of Technology is all set to celebrate its 30th Foundation Day on 19th February 2024. The Army Institute of Technology is all set to celebrate its 30th Foundation Day on 19th February 2024. On the auspicious day, AIT will be awarding the Lifetime Achievement award to Padma Vibhushan Dr. Anil Kakodkar, former Chairman of the Atomic Energy Commission of India. The Young Entrepreneur Award will be presented to Mr Ankush Tiwari, an alumnus of the AIT 2002 batch.

The ceremony will also witness awards to the Best All-around passing out student, Best Girl student of each branch, Best sportsperson, Best Teacher, Best Innovation, etc. A small demonstration of student projects has also been organized. Lt. Gen AK Ramesh, Commandant, College of Military Engineering is the Chief Guest for the function. The function will commence at 10.00 am on Monday, 19th February

2024 at AIT Campus. Director of AIT, Brig. (Retired) Abhay Bhat gave brief information about the function.



Army Institute of Technology (AIT) was established when Gen B.C. Joshi, PVSM AVSM, ADC (1935–1994), the then Chief of Army Staff of the Indian Army, saw the need for an engineering college for the children of all ranks of the Indian Army who face difficulties in pursuing their dreams due to constant transfers of their head of family and postings in remote areas.

AIT started with three engineering branches i.e. Computer Engineering, Electronics and Telecommunication Engineering, and Mechanical Engineering with an intake capacity of 60 students each. Later on, in the year 2002, the Information Technology branch with a student intake of 60 was added to the list.

Today AIT has achieved its vertical and horizontal growth by increasing the intake of Computer, Information Technology, and E&TC to 120 students each. AIT started the Master of Engineering Data Science course in the year 2023 with an intake capacity of 24 students. AIT is affiliated with Savitribai Phule Pune University. All these four branches are accredited by NBA and the college is also

accredited by NAAC. AIT, under the leadership of the Director Brig Abhay Bhat (Retd), is continuously working on the institute's vision to become a Globally Recognized‘ technical institute providing world-class education and research facilities to the wards of Défense personnel.

The institute emphasizes core values such as Excellence, Honesty, Integrity, teamwork, Continuous Learning, and Innovation. The Institute has well Qualified Teaching Faculty members to achieve academic excellence, under the guidance of Principal Dr. B. P. Patil. AIT is a residential institute with 30 acres of lush green campus, which has been designed to ensure the all-round development of students. Many clubs are active such as the Technical Club, Cultural and Music Club, Sports Club, NSS, Spirit Club, Open-Source Software Club, Centre of Excellence for AI and Robotics, Maths Club, Debating and Dramatic Club, Nature‘s Club, Fine Art Club, Radio Club, Cycling Club, Codes Club, Electric Vehicle club, Quantum Club etc. As AIT is situated in Pune, it has a strong industry connection. Industry-sponsored labs with Dassault Systemes, IBM, Texas Instrument, Nvidia, Agreeya Mobility, and FT 42 are useful for students to keep them upgraded to recent technologies. The placement record of the institute is one of the best in the Pune region. Every year many companies visit the campus for recruitment.

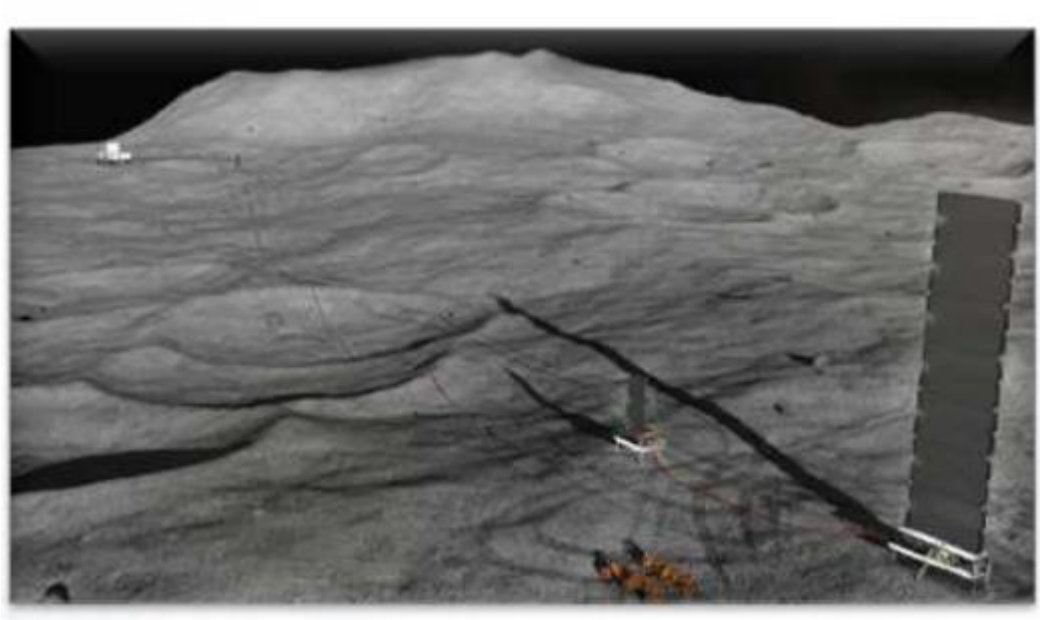
Major recruiters are Microsoft, Amazon, Google, Dreamplug Technologies, BNY Mellon, Goldman Sachs, Deutsche India, etc. The average placement of the institute is 96.66 % over the last three years. The highest Package bagged by a student in the last three years is Rs 1.12 Crore and the average salary of students in the last three years is Rs 14 Lakh.

Source website link: https://punemirror.com/pune/others/renowned-nuclear-scientist-dr-anil-kakodkar-to-be-honored-with-a-lifetimeachievement-award-by-the-army-institute-of/cid1708261438.htm

Nuclear Power on the Moon: NASA Wraps Up 1st Phase of Ambitious Reactor Project

03 February, 2024 | by Andrew Jones

The project aims to get a reactor up and running on the moon in the early 2030s.



Artist's illustration of a power system on the moon. NASA plans a sustained presence on the moon and eventually Mars. Safe, efficient, reliable energy will be key to future robotic and human exploration. (Image credit: NASA)

NASA is wrapping up the design phase of a project to develop concepts for a small, electricity-generating nuclear fission reactor for use on the moon. The Fission Surface Power Project aims to develop safe, clean and reliable energy sources on the moon, where each nighttime lasts around 14.5 Earth days. Such a system could play a big role in the agency's Artemis program for lunar exploration. NASA and the U.S. Department of Energy announced contracts to three companies — Lockheed Martin, Westinghouse and IX (a joint venture of Intuitive Machines and X-Energy) — for the initial phase back in 2022.

The trio were tasked with submitting an initial design for a reactor and subsystems, estimated costs and a development schedule that could pave the way for powering a sustained human presence on the lunar surface for at least 10 years.

"The lunar night is challenging from a technical perspective, so having a source of power such as this nuclear reactor, which operates independent of the sun, is an enabling option for long-term exploration and science efforts on the moon," Trudy Kortes, program director for technology demonstration missions within NASA's Space Technology Mission Directorate, said in a Jan. 31statement. A reactor could be especially useful at the lunar southpole, where permanently shadowed regions are thought to havetrapped water ice and other volatiles.

NASA next plans to extend Phase 1 contracts to refine the project's direction for Phase 2, which involves final reactor design for a lunar demonstration. Open solicitation for Phase 2 is expected to open in 2025. "We're getting a lot of information from the three partners,"said Lindsay Kaldon, Fission Surface Power project manager at NASA's Glenn Research Center in Cleveland. "We'll have to take some time to process it all and see what makes sense going into Phase 2 and levy the best out of Phase 1 to set requirements to design a lower-risk system moving forward."

After Phase 2, the target date for delivering a reactor to the launch pad is in the early 2030s, NASA stated. The agency set requirements for a 40-kilowatt reactor that uses low-enriched uranium and weighs no more than 13,200 pounds (6,000 kilograms). Beyond certain constraints, the agency allowed for flexibility, allowing the companies to bring creative and diverse approaches for technical review. In the U.S., 40 kW can, on average, provide electrical power for 33 households, ccording to NASA.

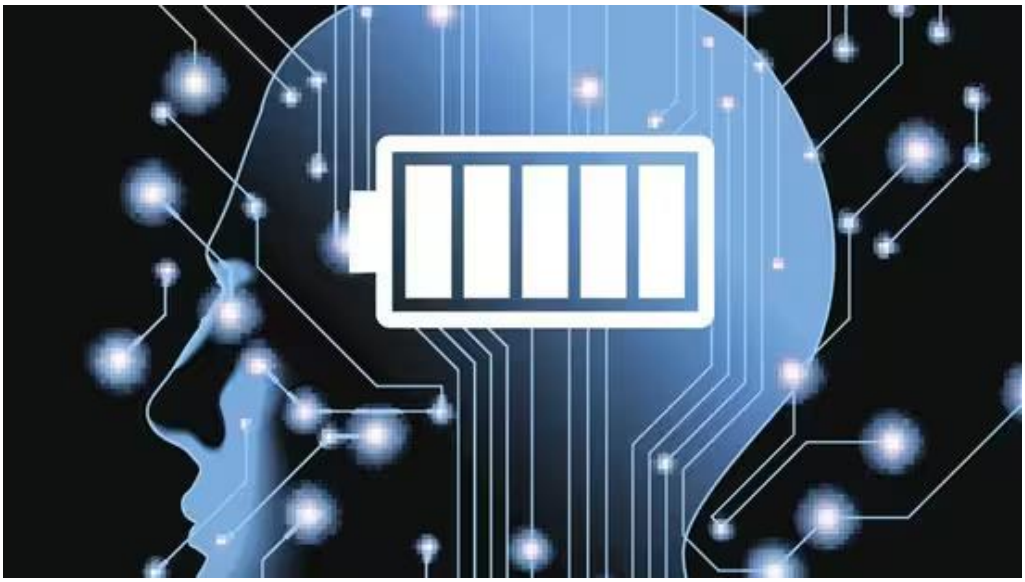
Artist's impression of two astronauts working on the moon during Artemis lunar operations. Such operations might be supported by nuclear power. (Image credit: NASA)

The reactor plan is one of a number of new nuclear plans for space, including launching a nuclear-powered spacecraft, named DRACO, by early 2026. NASA also recently awarded contracts for developing more efficient Brayton power converters, which are essential for converting thermal power from nuclear fission into electricity, to Rolls Royce North American Technologies, Brayton Energy and General Electric.

Source website link: https://www.space.com/nasa-moon-nuclear-reactor-project-first-phase-complete

IIT-Mandi developing indigenous quantum computer, will use photons for faster calculations

The computer, being developed as part of the National Quantum Mission, will be unique in its ability to analyse data and suggest solutions.



The Indian Institute of Technology, Mandi, is developing a first-of-its-kind indigenous room-temperature quantum computer that will use photons for faster calculations, according to officials.(Getty Images/iStockphoto)

The Indian Institute of Technology, Mandi, is developing a first-of-its-kind indigenous room-temperature quantum computer that will use photons for faster calculations, according to officials. The computer, being developed as part of the National Quantum Mission, will be unique in its ability to analyse data and suggest solutions with 86 per cent accuracy without traditional algorithms, they said.

Hindustan Times - your fastest source for breaking news! Read now.

Quantum computing is a rapidly emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers.

"We are constructing a room-temperature optical Quantum computer capable of solving feature learning and classification problems instantly.

"With a sophisticated user interface, quantum simulator and quantum processing capabilities in place, our computer will operate as a graphics processor (GPU) instead of CPU, seamlessly processing inputs such as videos or photographs," said C S Yadav, the chairperson of the Center for Quantum Science and Technologies (CQST) at IIT-Mandi

Approaching 1.5 °C: how will we know we've reached this crucial warming mark?

Assessing global mean temperature rise using the average warming over the previous one or two decades will delay formal recognition of when Earth breaches the Paris agreement's 1.5 °C guard rail. Here is what's needed to avoid the wait.

By Richard A. Betts, Stephen E. Belcher, Leon Hermanson, Albert Klein Tank, Jason A. Lowe, Chris D. Jones, Colin P. Morice, Nick A. Rayner, Adam A. Scaife & Peter A. Stott

Nature 624, 33-35 (2023) doi: https://doi.org/10.1038/d41586-023-03775-z

People in Tokyo carried parasols for shade as temperatures exceeded 35 °C in the Japanese capital in July 2023. Credit: Richard A. Brooks/AFP via Getty

The world is already more than 1°C warmer on average than it was before industrial times, owing to greenhouse gases released from human activities. And

that value is rising. The Intergovernmental Panel on Climate Change (IPCC) projects that there is at least a 50% chance that long-term global warming will overshoot 1.5 °C in the next decade, even with ambitious emissions cuts.

That matters because this target is written into the 2015 Paris climate agreement. Breaching it will trigger questions on what needs to be done to meet the agreement's goal — to curb human-induced climate change. For example, its aim of "pursuing efforts to limit the temperature increase to 1.5 °C" would then mean taking action to reverse global warming, not just stopping it, a much greater demand. A breach will also inevitably prompt assessments of the observed impacts of exceeding 1.5 °C.

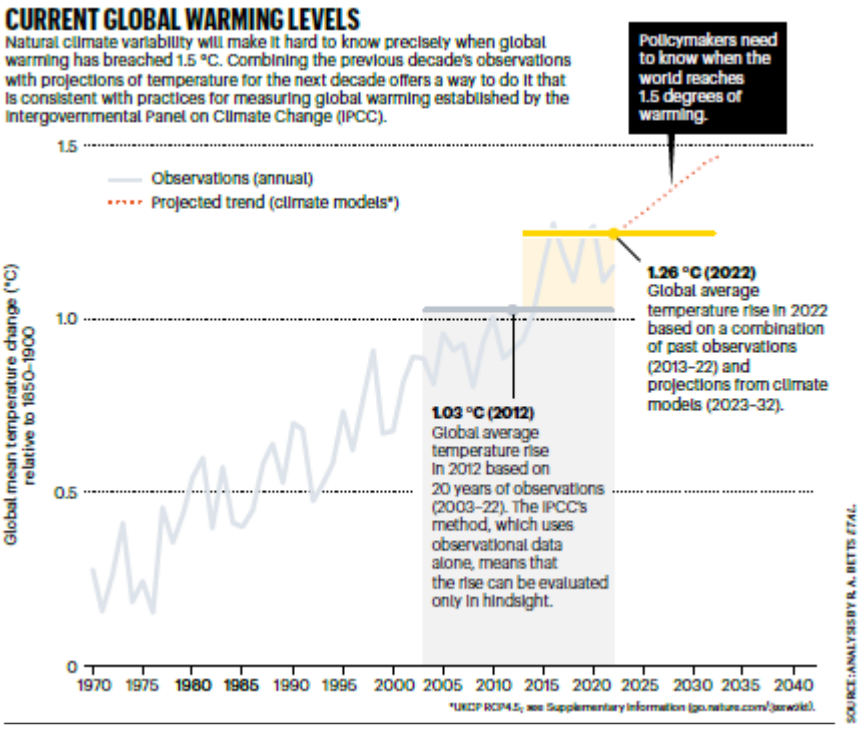
It might come as a surprise, then, to hear that the Paris statement contains no formally agreed way of defining the present level of global warming. The pact does not even define 'temperature increase' explicitly and unambiguously. Without an agreed metric, there can be no consensus on when the 1.5 °C level has been reached. This is likely to result in distraction and delay just at the point when climate action is most urgent.

Is it too late to keep global warming below 1.5 °C? The challenge in 7 charts

A key issue is that global temperatures do not increase smoothly. The brief ups and downs that occur over weeks to years owing to natural climate variability (caused, for instance, by El Niño events and the effects of gases given off by volcanic activity) are superimposed on the long-term warming trend from human influences. For example, the global mean temperature rise exceeded 1.5 °C briefly for a month or more in 2016, 2017, 2019, 2020 and 2023.

As far as the Paris agreement is concerned, it's recognized that such brief warm spells don't count as breaching 1.5 °C. And even an anomalously warm year would not do so. The World Meteorological Organization (WMO) predicts there is a 66% chance that the global mean temperature excess will go above 1.5 °C for at least one year in the next 5 years1. However, even this is likely to be a temporary anomaly.

What would count as passing 1.5 °C? A method is needed for filtering out such natural climate cycles. To smooth temperature wiggles in model projections of future climate, the latest IPCC assessment report, AR6, defined the 1.5 °C mark and other global warming levels (GWLs) in terms of projected 20-year averages relative to the average for 1850–1900. The year of exceedance of a GWL is the midpoint of the 20-year period at that level. By this definition, 1.5 °C of warming would be confirmed once the observed temperature rise has reached that level, on average, over a 20-year period — in other words, a decade after crossing the 1.5 °C level. That risks a delay in recognizing and reacting to the crossing point (see 'Current global warming levels').



Researchers and the policy community need to agree urgently on a metric for determining the current level of global warming for policy purposes. Once defined, the metric should be formally adopted for use in the context of the Paris agreement. It should be consistent with established IPCC practices, and should allow the crossing of 1.5 °C to be recognized without delay. Here, we propose a starting point for such a metric.

Multiple metrics

In observational records of climate, the average global temperature over the past two decades (2003–22) has been 1.03 °C above that for 1850–1900 (although uncertainties in the data mean that the true value could be as low as 0.87 °C or as high as 1.13 °C; see Supplementary information)2. And measurements from 2002 to 2021 indicate that warming first passed 1 °C in 2011. But we don't know what the 20-year average is now, centred around 2023. Assuming the world stays on its

current warming trajectory, IPCC projections suggest that 1.5 °C will be breached around 2030, give or take a decade3. But, on the basis of 20-year averages, the passing of 1.5 °C would not be formally recognized until around 2040. Shortening the period over which the average is calculated doesn't help much. Ten-year averages4 are reasonably representative of longer-term averages5 and reduce the delay to five years. But that is still a long time when action is needed urgently. Shortening the average period further isn't useful, because natural variability then dominates.

Climate loss-and-damage funding: how to get money to where it's needed fast

A more instantaneous indicator of the current level of long-term warming is needed. Several such methods are already in use. These include: finding the end point of a linear trend over the past 30 years (see go.nature.com/3ssvpwx); using more sophisticated methods for statistical smoothing over short time frames (see go.nature.com/3mqsr7g); and calculating the human contribution to warming from data on changes in the concentrations of greenhouse gases and aerosols. Each method can offer a slightly different estimate of current warming, depending on which data, algorithms and assumptions are used. Nonetheless, there is broad

agreement on some things, such as that warming in 2022 was about 1.24 °C (with an uncertainty range between 1.0 °C and 1.6 °C), and that 1.0 °C warming was exceeded around 2011 or 2012.

There have been times when the differences between methods were greater, either because the rate of warming changed rapidly so a linear trend did not represent the long-term change, or because large natural variability led to a difference between the observed warming and the human contribution. For example, there is less agreement on the year in which 0.5 °C of warming was exceeded, put at some time between 1982 and 1988. This demonstrates the potential for confusion on recognizing the crossing of 1.5 °C if a single indicator is not agreed.

However, there are two key problems with using any of these indicators in the context of the Paris agreement. Both stem from the need for consistency with existing IPCC practice.

Informing Policy

First, to inform policy, the indicator for monitoring the approach to 1.5 °C must be future-proof — later changes in the definition could undermine the credibility of using GWLs for scientific advice. Any definition must be consistent with how 1.5 °C is already defined by the IPCC; that is, using 20-year averages attached to a midpoint.

Corals were moved to land for safety when a July heatwave warmed waters near Florida.Credit: Carolyn Cole/Los Angeles Times via Getty

Second, the metric should be consistent with how the 1.5 °C level will be defined after it has retreated into the past as a baseline for future impact assessments. The IPCC already uses long-term averages over recent decades for such baselines; it does not use the end point of 30-year trends or statistical smoothing. And, importantly, baseline periods for impact studies are defined in terms of observed temperature change, not calculations of human-induced warming, because the impacts depend on the actual temperature experienced.

The instantaneous metrics are inconsistent with these requirements. And the IPCC method alone will not suffice 20 years of observed data will not be available in the exceedance year, because it is only halfway through the 20-year period. Another approach is needed.

A new approach

We propose a new indicator the 20-year average temperature rise centred around the current year. This is estimated by blending observations for the past 10 years

with climate model projections or forecasts for the next 10 years, and taking an average over the combined 20-year period. This ‘current global warming level’ (CGWL) indicator meets our two criteria. it allows consistency with established IPCC definitions, and provides an instantaneous indicator of current warming.Testing this approach using different models and emissions scenarios, we have found that the CGWL centred on the end of 2022 is around 1.26 °C, with an uncertainty range from the forecasts of 1.13 °C to 1.43 °C, mainly owing to climate variability (see Supplementary information). Only a small part of the uncertainty comes from assumptions concerning emissions over the coming decade. This estimate is in line with those from the existing instantaneous values, but our metric is more future-proof and consistent with the approaches that are already used to support the Paris agreement.

Climate loss-and-damage funding: a mechanism to make it work

Next steps

First, the international community needs to recognize the need for a single, agreed metric for crossing the 1.5 °C threshold and anticipate events leading up to it. This period will be marked by a series of milestones. These include: the first year with a

global temperature anomaly above 1.5 °C in one or more data sets; the exceedance of 1.5 °C using various instantaneous indicators (including our CGWL metric); and, a decade later, confirmation that 1.5 °C had been exceeded in the IPCC 20-year average.

An instantaneous indicator for policy purposes will provide clarity that the first individual year at 1.5 °C will not count as breaching the Paris guard rail, and will reduce delays that would result from waiting until the end of the 20-year period. Discussions on the nature of this indicator should start immediately.

We encourage the IPCC to tackle this issue in a Special Report ahead of its seventh assessment report (AR7), which is not expected to be published until about 2030 by which time, global warming might already have exceeded 1.5 °C or be close to doing so.

The IPCC should examine indicators such as ours in depth. If a suitable metric is agreed, a robust and transparent process for calculating and communicating it should be developed. It should make use of well-established sources and practices as far as possible. For example, observations could come from the WMO's State of the Global Climate report (go.nature.com/3qqngme), and projections or forecasts could use the IPCC's assessed warming rates8 and the WMO's decadal forecasts.

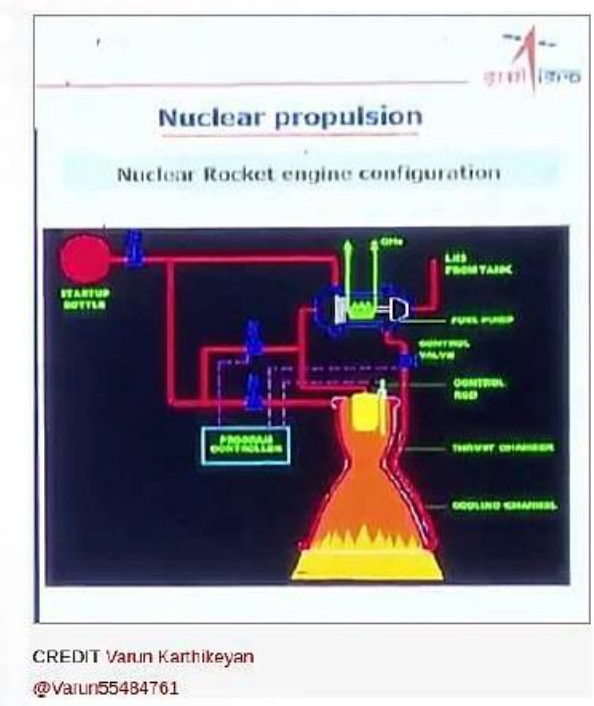
Disaster early-warning systems are ‘doomed to fail’ — only collective action can plug the gaps

Researchers will need to decide which pathway of future greenhouse-gas and aerosol concentrations should be used for the central estimate of the forecast. The choice will need careful communication, because it could be taken as a statement of an expected policy future, even though it actually makes little difference when compared with uncertainties caused by natural climate variability.Uncertainties in the combination of observations and forecasts will need to be quantified more precisely, and a system for communicating them developed. For example, formal identification of the passing of 1.5 °C could be accompanied by an IPCC-style confidence or likelihood statement, such as ‘it is likely that the current global warming level has now reached (or exceeded) 1.5 °C. In subsequent years, this might become ‘it is very likely that the CGWL exceeded 1.5 °C in year X’. This evaluation would become more certain as more observations came in over the following decade. Other technical details remain to be discussed. These include whether the projection of the next ten years should include a specific forecast of natural variability (as in the WMO’s decadal forecasts), or whether the possible outcomes of variability should just be treated statistically. We recommend that work commence urgently to develop a system to put this definition into use. Researchers must ensure that it is ready well before the controversy begins over whether global warming has exceeded 1.5 °C.

ISRO Unveils its Vision for Nuclear Propulsion: a Peek into the Engine‘s Heart

29 December, 2023 | by Indian Defence Research Wing

Source website link: https://idrw.org/isro-unveils-its-vision-for-nuclear-propulsion-a-peek-into-the-engines-heart/#google_vignette



India‘s space agency, the Indian Space Research Organisation (ISRO), has taken a giant leap forward in its pursuit of deep-space exploration with the unveiling of its configuration for a nuclear propulsion system. This ambitious project promises to revolutionize India‘s spacefaring capabilities, enabling missions to distant celestial bodies and pushing the boundaries of human knowledge.

Traditional chemical rockets, while powerful, have limitations, especially for missions beyond the solar system. Their reliance on carrying vast quantities of fuel

restricts their range and payload capacity. Nuclear propulsion, on the other hand, offers a game changing solution. By utilizing the immense energy released from nuclear fission or fusion, nuclear engines can generate significantly more thrust with minimal fuel consumption, making them ideal for long-duration, deep-space missions. While details remain under wraps, ISRO has provided glimpses into the key components of its proposed nuclear engine.

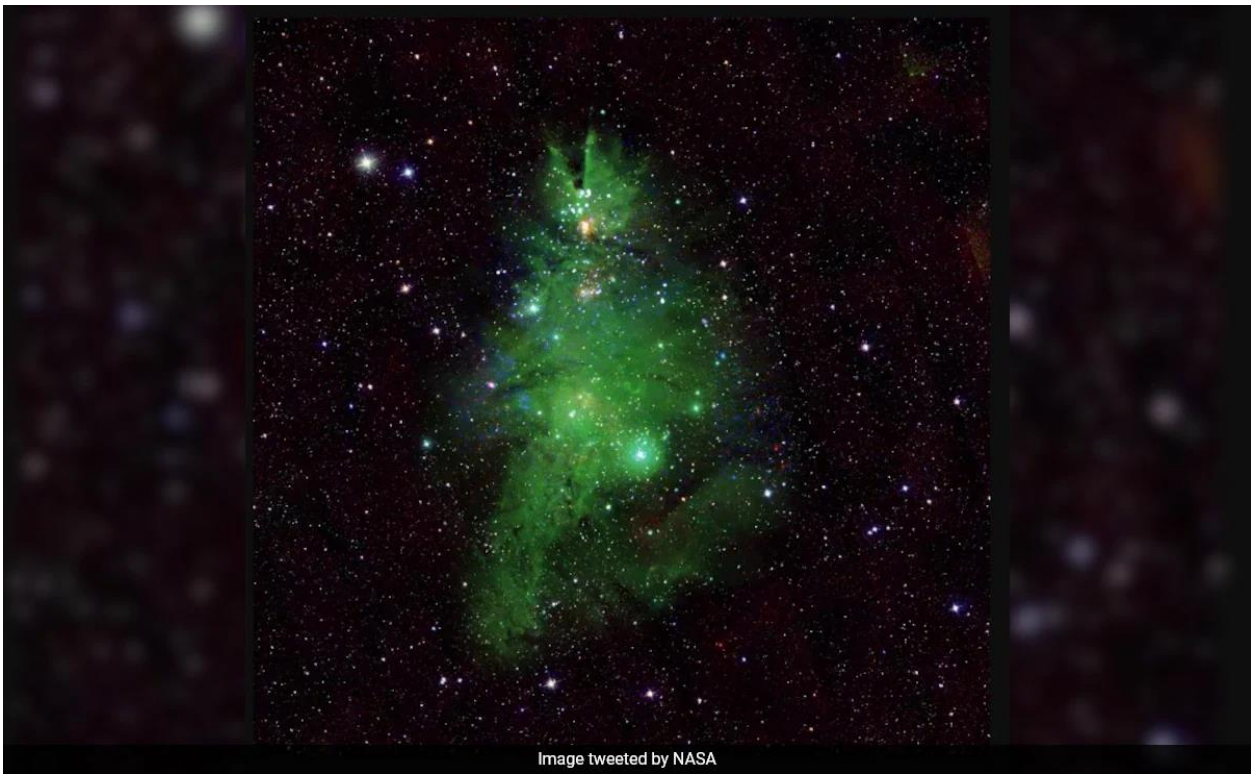
Here are some of the crucial elements:

1. **Startup System:** This system initiates the nuclear chain reaction, bringing the engine to life
2. **Control Valves:** These valves regulate the flow of propellants and reactor coolant, ensuring optimal engine operation.
3. **Control Rods:** These rods adjust the reactivity of the reactor core, controlling the power output and preventing overheating.
4. **Cooling Channels:** These intricate channels circulate coolant through the reactor core, absorbing heat and preventing meltdowns
5. **Thrust Chamber:** This chamber converts the hot, pressurized gas from the reactor into thrust, propelling the spacecraft.
6. **Program Controller:** This sophisticated computer system monitors and manages all engine functions, ensuring safe and efficient operation
7. **Fuel Pump:** This pump delivers the nuclear fuel to the reactor core, maintaining a steady flow for continuous operation.

NASA's James Webb Space Telescope Captures 'Cosmic Christmas Tree' Shining In Space

The image enhances the resemblance to a Christmas tree through choices of color and rotation.

ScienceEdited by Nikhil PandeyUpdated: December 20, 2023 11:37 am IST



The Christmas Tree Cluster is a swarm of stars and gas some 2,500 light-years from Earth.

As the world gears up for the festive season, the National Aeronautics and Space Administration (NASA) has shared a stunning image of a space Christmas tree, adding an out-of-this-world touch to the holiday cheer. The space agency described the image as a shot of a cluster of young stars looking decidedly like a cosmic Christmas tree. The cluster, known as NGC 2264, is in our Milky Way Galaxy, about 2,500 light-years from Earth. Some of the stars in the cluster are relatively small, and some are relatively large, ranging from one tenth to seven times the mass of our sun. In this composite image, the cluster's resemblance to a Christmas tree has been enhanced through image rotation and color choices. Optical data is

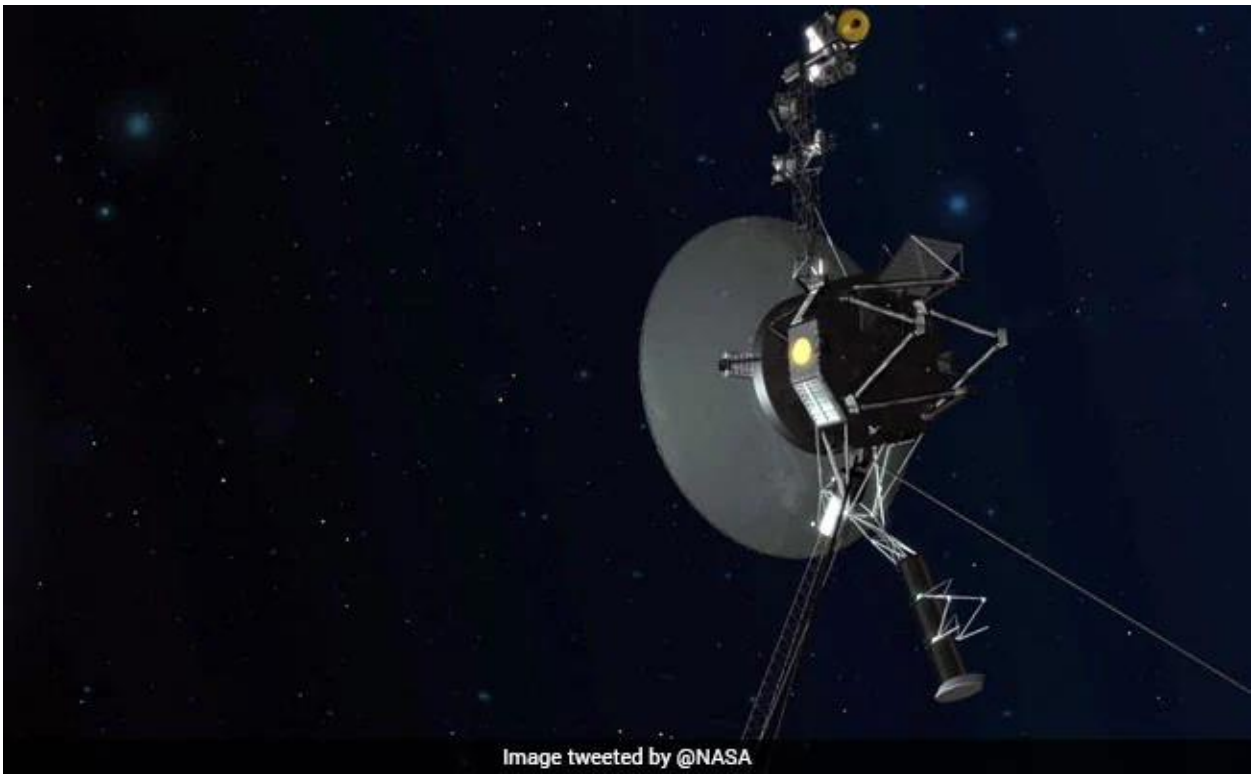
represented by wispy green lines and shapes, which create the boughs and needles of the tree shape. It's beginning to look a lot like cosmos.

Our @ChandraXray Observatory recently spotted the blue-and-white lights that decorate the "Christmas Tree Cluster," a swarm of stars and gas some 2,500 light-years from Earth: The space agency describes in an image article that young stars, like those in NGC 2264, are volatile and undergo strong flares in X-rays and other types of variations seen in different types of light. The coordinated, blinking variations shown in this animation, however, are artificial to emphasize the locations of the stars seen in X-rays and highlight the similarity of this object to a Christmas tree. In reality, the variations of the stars are not synchronized.The variations observed by Chandra and other telescopes are caused by several different processes. Some of these are related to activity involving magnetic fields, including flares like those undergone by the Sun-but much more powerful-and hot spots and dark regions on the surfaces of the stars that go in and out of view as the stars rotate. There can also be changes in the thickness of gas obscuring the stars and changes in the amount of material still falling onto the stars from disks of surrounding gas.

NASA's Voyager 1s is Glitching, Sending Nonsensical Messages Back To Earth

NASA reports that the spacecraft, currently situated 15 billion miles away from our planet, is experiencing a communications glitch.

ScienceEdited by Anjali ThakurUpdated: December 18, 2023 8:57 am IST



NASA receives the transmitted data in binary code

After traversing billions of miles and spending almost **five decades** in space, NASA's Voyager 1 space probe has started sending nonsensical data back to Earth. Launched in 1977, the spacecraft was originally on a five-year mission to fly past Jupiter and Saturn but somehow it has continued to venture further into space for the past 46 years. It has become the first human-made object to leave the solar system, BBC reported. In 2023, it typically takes over 22 hours for signals from Voyager 1 to reach Earth. However, NASA reports that the probe, currently situated 15 billion miles away from our planet, is experiencing a communications

glitch. Voyager 1 is equipped with three onboard computers: one dedicated to flight data, collecting information from the spacecraft's scientific instruments, and another handling engineering data, functioning like a coded health bar reflecting Voyager 1's status.

On Earth, NASA receives the transmitted data in binary code, a language using zeroes and ones to represent letters, numbers, and symbols. Binary code is named as such due to its reliance on only two symbols. However, a notable issue has arisen as the probe is now exhibiting repetitive behaviour, consistently sending the same code snippet. This repetition has prompted scientists to suspect a malfunction in the spacecraft. The NASA Jet Propulsion Laboratory, responsible for managing numerous robotic missions, addressed the situation on social media, stating, "The NASA Voyager team is investigating an issue with Voyager 1's Flight Data System. The spacecraft is receiving and executing commands sent from Earth but not returning usable data."

Last year, NASA revealed its decision to deactivate certain systems on both Voyager 1 and its counterpart, Voyager 2. This strategic move aims to maximize their operational lifespan until their plutonium power sources are depleted. Anticipations suggest that these probes will remain functional until 2030. After reaching this milestone, their transmitters and instruments will cease to function, leading the spacecraft to undergo a shutdown, ultimately drifting aimlessly through space. These remarkable spacecraft hold the distinction of being the only human-made objects to operate beyond the heliosphere expansive region of the Sun's magnetic fields and particles that extend far beyond the orbit of Pluto.

Scientists Developed Portable Nuclear Reactor with Amazing Feature: Transformative for our Economy, Industry, and Communities‘

25 December, 2023 | by Rick Kazmer

Source website link: https://www.thecooldown.com/green-tech/westinghouse-evinci-nuclear-reactor-saskatchewan-canada/

The eVinci will reduce up to 55,000 tons of air pollution each year, according to the company. A small nuclear reactor that can run for eight years or more without water is scheduled to go online by 2029 in Saskatchewan, Canada. In November, Saskatchewan‘s government announced an $80 million CAD (about $59 million USD) project from the Saskatchewan Research Council to demonstrate the microreactor‘s capability. Theunit, called an eVinci, is being built by Westinghouse. This project has the opportunity to be transformative for our economy, industry, and communities,‖ Premier Scott Moe said in a government press release. Microreactors provide a custom solution for Saskatchewan‘s unique energy needs.

It‘s also cleaner energy, as each eVinci will reduce up to 55,000 tons of air pollution each year, according to Westinghouse. The unit will be capable of producing five megawatts of electricity, over 13 megawatts of high-temperature heat, or operating in combined heat and power mode, per the council. For reference, the Nuclear Regulatory Commission reported in 2012 that a single megawatt of capacity for a conventional power plant produces energy similar to what is used by 400 to 900 homes in a year.

Westinghouse considers their unit revolutionary technology for future energy needs, per a video clip. Microreactors are notable for their portability and potential to power remote locations. The U.S. Energy Department reports that several kinds are in development in the United States. The eVinci will be installed above ground with a small footprint. The unit‘s supporting infrastructure will fit inside a hockey rink. The power can be integrated into existing grids, and it can be paired with renewable power sources, as well. With its heat pipe technology, the system doesn‘t need water to cool down. After an approximate eight-year service life, the unit can be hauled away for disposal, and another one can be plugged in, all per Westinghouse. A simple design, functioning like a battery, the clip‘s narrator says.

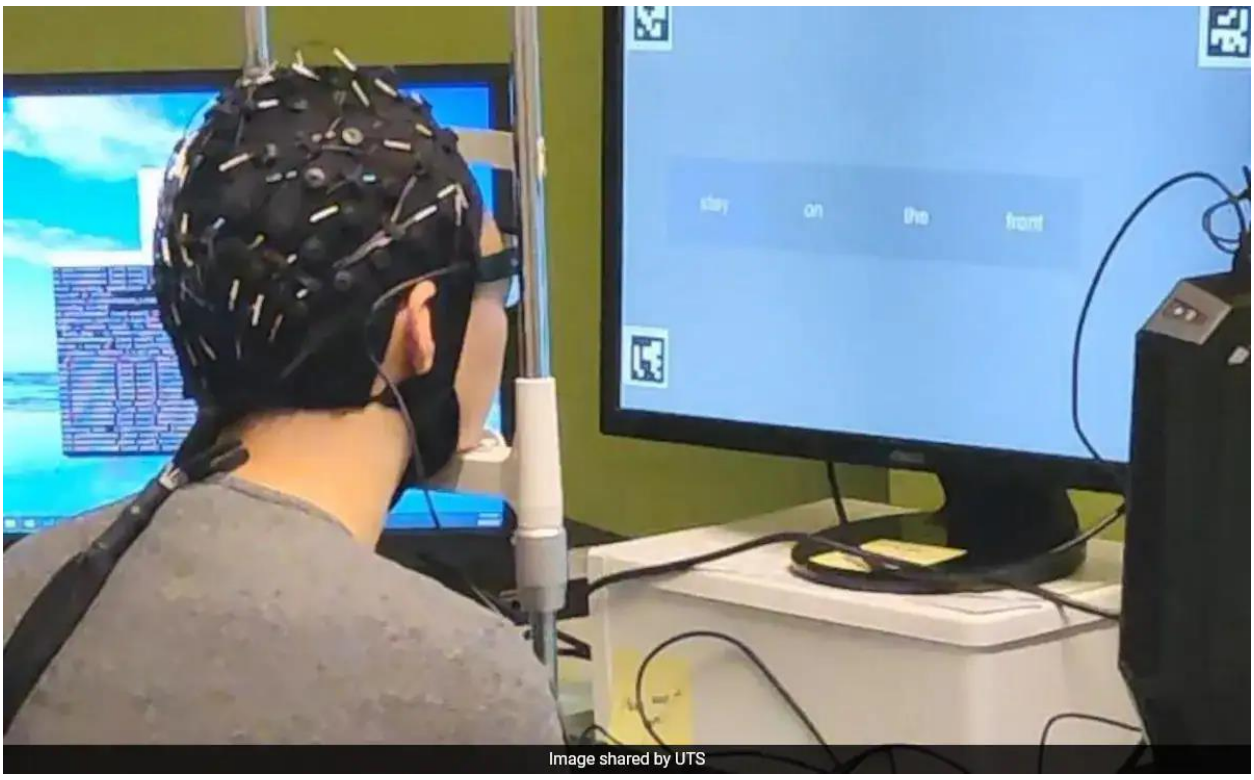
There are 54 commercial nuclear power plants in the U.S. (per the Energy Information Administration) and six nuclear power stationsin Canada (per the Canadian government).

In the U.S., the plants create about 2,205 tons of nuclear waste a year, less than half the volume of an Olympic swimming pool. The fuel comes in the form of ceramic pellets (no oozy drums), and researchers are discovering better ways to deal with the waste, including nuke-loving bacteria. Westinghouse experts report

that the eVinci‘s used fuel will be returned to the company or placed deep underground for long-term storage. The design eliminates risk from high pressure and coolant loss. What‘s more, the heat the unit makes could be used for industrial work, all per the company. The council sees this first eVinci as a proof-of-concept unit, preparing the way for more in the future. What we learn through this project will prepare [the council] to assist communities and industries in future projects,‖ council CEO Mike Crabtree said in the press release.

Scientist Develop First Mind-Reading Helmet That Can Write What You Think

The scientists also stated that this advancement is non-invasive, relatively inexpensive and easily transportable as compared to Elon Musk's Neuralink



A researcher testing the new mind-reading technology wearing the cap.

Researchers at the University of Technology Sydney's GrapheneX-UTS Human-centric Artificial Intelligence Centre have created a portable, non-invasive device that can translate silent thoughts into text, a first for the world. This invention can help people who suffer from illnesses or injuries that prevent them from speaking, such as paralysis or a stroke, to communicate with others. It might also make smooth communication possible between humans and machines, which would be useful for controlling robots or bionic arms.

According to the press release, participants in the study read texts silently while donning a cap that used an electroencephalogram (EEG) to capture electrical activity in their brains through their scalps. The moment the sensors detect that a participant is thinking, they begin to function and send them a random text. It records their brain waves while they mentally read the sentences, and then it translates those waves into a different text that looks quite similar to the original. Further, EEG recordings use a smart artificial intelligence model called DeWave to transform the results and recordings into text, giving users a unique mind-reading experience. According to a video shared by the university, in one of the tests, a participant was asked to think "Good afternoon! I hope you're doing well. "I'll start with a cappuccino, please, with an extra shot of espresso." A screen displayed the AI at work turning the brainwaves into a written response after a short while. The result was, "Afternoon! You well? Cappuccino, Xtra shot. Espresso."

CT Lin, Director of the GrapheneX-UTS HAI Centre, who led the research said, "This research represents a pioneering effort in translating raw EEG waves directly into language, marking a significant breakthrough in the field. It is the first to incorporate discrete encoding techniques in the brain-to-text translation process, introducing an innovative approach to neural decoding. The integration with large language models is also opening new frontiers in neuroscience and AI."

Overall, certain statements were more difficult than others, but they still got a 40 per cent success rate out of the 29 participants evaluated. "The model is more adept at matching verbs than nouns. However, when it comes to nouns, we saw a tendency towards synonymous pairs rather than precise translations, such as 'the man' instead of 'the author'. We think this is because when the brain processes these words, semantically similar words might produce similar brain wave patterns. Despite the challenges, our model yields meaningful results, aligning keywords and forming similar sentence structures," study author Yiqun Duan said.

The use of EEG signals received through a cap rather than electrodes implanted in the brain results in a noisier output. However, in terms of EEG translation, the study demonstrated a performance that exceeded previous benchmarks.

On the other hand, the scientists also stated that this advancement is non-invasive, relatively inexpensive and easily transportable as compared to Elon Musk's Neuralink, brain-chip startup. Recently, it received approval from an independent review board to begin recruitment for the first human trial of its brain implant for paralysis patients. The study will use a robot to surgically place a brain-computer interface (BCI) implant in a region of the brain that controls the intention to move, Neuralink said, adding that its initial goal is to enable people to control a computer cursor or keyboard using their thoughts alone. The billionaire has grand ambitions for Neuralink, saying it would facilitate speedy surgical insertions of its chip devices to treat conditions like obesity, autism, depression and schizophrenia.

Atomic Power: Discovering the Inventor of Atomic Batteries

01 January, 2023 | by Cassy Yingling

Source website link: https://citizenside.com/technology/atomic-power-discovering-the-inventor-of-atomic-batteries/

What is Atomic Power?

The Marvel of Atomic Power

Atomic power, also known as nuclear power, is the energy that is released through the process of nuclear reactions. At its core, atomic power is derived from the immense energy stored within the nucleus of an atom. This energy can be harnessed through controlled nuclear reactions, producing heat which is then converted into electricity. The concept of atomic power has revolutionized the way we generate energy, offering a potent and efficient alternative to traditional fossil fuels. At the heart of atomic power lies the remarkable phenomenon of nuclear fission, where the nucleus of an atom is split into smaller parts, releasing an enormous amount of energy. This process is the driving force behind nuclear power plants, where controlled fission reactions take place to generate electricity on a massive scale. The utilization of atomic power has significantly reduced our dependence on non-renewable energy sources, marking a pivotal step towards sustainable energy production.

Moreover, atomic power has found applications beyond electricity generation. It has been instrumental in propelling space exploration, with nuclear-powered spacecraft offering extended mission durations and increased power generation capabilities. The boundless potential of atomic power continues to fuel advancements in various fields, from medicine to industrial applications, heralding a new era of energy innovation.

The History of Atomic Batteries

Pioneering the Use of Atomic Energy in Batteries

The journey of atomic batteries traces back to the mid-20th century, a time marked by ground breaking advancements in nuclear technology. The concept of atomic batteries, also known as nuclear batteries or radioisotope thermoelectric generators (RTGs), emerged as a revolutionary solution to power remote and challenging environments where traditional power sources were impractical.

The inception of atomic batteries can be attributed to the pioneering work of Dr. Paul Rappaport, a distinguished physicist and innovator. In the 1950s, Dr. Rappaport spearheaded research into harnessing the energy from radioactive isotopes to generate electricity. His relentless pursuit of this novel approach led to the development of the first functional atomic battery, marking a significant milestone in the realm of portable power sources. One of the pivotal moments in the history of atomic batteries occurred during the space race era, where these innovative power systems played a pivotal role in powering spacecraft and satellites. The successful deployment of atomic batteries in space missions

demonstrated their reliability and durability in the harsh conditions of outer space, solidifying their status as a game-changing technology.

Over the years, the evolution of atomic batteries has been propelled by collaborative efforts across scientific disciplines and engineering domains. The integration of advanced thermoelectric materials and enhanced safety features has elevated the efficiency and applicability of atomic batteries, expanding their utility in diverse fields, including deep-sea exploration, remote sensing, and medical implants.

Today, the legacy of atomic batteries endures as a testament to human ingenuity and the relentless pursuit of innovation. From powering long-duration space missions to enabling critical applications in remote and hostile environments, atomic batteries continue to shape the landscape of modern technology, offering a reliable and sustainable power solution for the most demanding scenarios.

The Inventor of Atomic Batteries

Unveiling the Visionary Mind Behind Atomic Batteries

The inception of atomic batteries can be attributed to the pioneering work of Dr. Paul Rappaport, a distinguished physicist and innovator. Dr. Rappaport‘s visionary contributions to the field of nuclear technology laid the foundation for the development of atomic batteries, revolutionizing the landscape of portable power sources. Dr. Paul Rappaport, a trailblazing scientist renowned for his expertise in nuclear physics, embarked on a transformative journey to harness the potent energy of radioactive isotopes for practical applications. His unwavering dedication and relentless pursuit of innovation led to the conceptualization and realization of the first functional atomic battery in the 1950s. Driven by a profound understanding of nuclear science and thermoelectric principles, Dr. Rappaport envisioned a compact and reliable power source that could operate autonomously

in remote and challenging environments. His pioneering research culminated in the successful demonstration of atomic batteries, marking a paradigm shift in the realm of energy technology. Dr. Rappaport‘s seminal contributions extended beyond the conceptualization of atomic batteries; he played a pivotal role in advancing the safety and efficiency of these innovative power systems. His interdisciplinary approach, integrating principles from nuclear physics, materials science, and engineering, propelled the evolution of atomic batteries, paving the way for their widespread adoption in diverse applications.

Furthermore, Dr. Rappaport‘s visionary outlook and commitment to excellence fostered a legacy of innovation that continues to inspire scientists and engineers worldwide. His ground-breaking work not only revolutionized the field of portable power sources but also catalyzed advancements in space exploration, deep-sea research, and medical technology.

Today, the enduring impact of Dr. Paul Rappaport‘s pioneering spirit resonates in the continued advancements and applications of atomic batteries, serving as a testament to the transformative power of visionary thinking and scientific ingenuity.

How Atomic Batteries Work

Unveiling the Intricacies of Atomic Battery Operation Atomic batteries, also known as nuclear batteries or radioisotope thermoelectric generators (RTGs), harness the energy released from the natural decay of radioactive isotopes to generate electricity. The fundamental principle underpinning the functionality of atomic batteries lies in the conversion of heat energy, emitted during the decay process, into electrical power through thermoelectric mechanisms.

At the core of an atomic battery is a radioactive isotope, such as plutonium-238 or strontium-90, chosen for its decay characteristics and energy output. As the radioactive material undergoes decay, it emits high-energy particles and gamma

radiation, generating substantial heat within the atomic battery‘s containment system. This heat serves as the primary energy source for the battery‘s operation.

The heat generated by the radioactive decay is then utilized to thermally excite thermocouples, which are composed of dissimilar conductive materials. This thermal excitation induces a flow of electrons, creating an electric potential difference across the thermocouple junctions, thus producing a continuous electrical current. The generated electricity is then harnessed to power electronic devices, sensors, or other equipment, making atomic batteries an invaluable source of long-lasting and autonomous power.

One of the defining features of atomic batteries is their longevity and reliability, attributed to the enduring nature of radioactive decay. Unlike traditional chemical batteries that rely on reversible chemical reactions and deplete over time, atomic batteries can provide a consistent power output for extended durations, making them ideal for applications requiring sustained and maintenance free power sources.

Moreover, the inherent resilience of atomic batteries to harsh environmental conditions, such as extreme temperatures and radiation exposure, further enhances their appeal for deployment in remote and challenging environments, including outer space, deep sea exploration, and remote monitoring systems. The ingenious utilization of nuclear energy in atomic batteries exemplifies a remarkable synergy of physics, materials science, and engineering, offering a robust and sustainable power solution that continues to drive advancements in diverse technological domains.

Applications of Atomic Batteries

Empowering Diverse Technological Frontiers

The versatility and reliability of atomic batteries have propelled their integration into a myriad of pioneering applications, spanning from space exploration to medical implants, where traditional power sources are impractical or unfeasible.

The unique attributes of atomic batteries, including their longevity, autonomy, and resilience, have positioned them as indispensable power solutions in the following domains:

Space Exploration: Atomic batteries have played a pivotal role in powering numerous space missions, including deep-space probes, rovers, and satellites. Their ability to provide sustained and autonomous power in the harsh and remote environment of outer space has been instrumental in extending the duration and capabilities of space exploration endeavours.

Remote Sensing and Monitoring: In remote and inaccessible locations, such as deep-sea environments, Arctic research stations, and remote monitoring systems, atomic batteries serve as reliable power sources for continuous operation of sensors, data collection devices, and communication equipment, enabling persistent monitoring and research activities.

Medical Implants and Devices: The longevity and compact form factor of atomic batteries make them suitable for powering medical implants, such as pacemakers and neurostimulators, where the longevity and reliability of power sources are critical for patient well-being and device functionality.

Defense and Security Systems: Atomic batteries find application in defense and security systems, providing enduring and autonomous power for remote surveillance equipment, communication nodes, and unmanned aerial vehicles (UAVs) deployed in challenging and hostile environments.

Environmental Monitoring and Research: Atomic batteries facilitate long-term environmental monitoring and research initiatives, powering autonomous buoys, weather stations, and environmental sensors in remote and ecologically sensitive

areas, where continuous and unattended operation is essential. The integration of atomic batteries in these diverse applications underscores their pivotal role in enabling sustained and autonomous power solutions across a spectrum of technological frontiers. As advancements in materials science and nuclear technology continue to enhance the efficiency and safety of atomic batteries, their impact on shaping the future of energy autonomy and technological innovation is poised to expand even further.

Advantages and Disadvantages of Atomic Batteries

Weighing the Pros and Cons of Nuclear Power Sources

Atomic batteries, heralded for their remarkable longevity and autonomous power generation capabilities, offer a host of advantages that have positioned them as indispensable energy solutions in various applications. However, alongside their strengths, atomic batteries also present certain limitations and considerations that warrant carefulassessment.

Advantages:

Longevity: Atomic batteries exhibit an unparalleled longevity, providing sustained power output for extended durations, making them ideal for applications requiring maintenance-free and autonomous power sources.

Autonomy: The self-sustaining nature of atomic batteries, coupled with their resilience to environmental factors, enables autonomous operation in remote and challenging environments, such as outer space, deep-sea, and Polar Regions.

Reliability: The enduring nature of nuclear decay ensures a consistent and reliable power output, offering a dependable energy source for critical applications, including space missions, remote sensing, and medical implants.

Compact Form Factor: Atomic batteries can be designed in compact configurations, making them suitable for integration into space-constrained devices and systems, such as medical implants and miniaturized sensors.

Environmental Resilience: Atomic batteries exhibit resilience to extreme temperatures, radiation exposure, and harsh environmental conditions, enhancing their suitability for deployment in challenging and hostile settings.

Disadvantages:

Radioactive Material: The utilization of radioactive isotopes in atomic batteries raises concerns regarding the handling, storage, and disposal of radioactive materials, necessitating stringent safety protocols and regulatory compliance.

Complexity of Design: Atomic batteries require intricate engineering and safety measures to contain and harness the energy from radioactive decay, adding complexity to their design and manufacturing processes.

Limited Power Output: While atomic batteries offer sustained power generation, their output levels are relatively low compared to conventional energy sources, limiting their applicability in high power demanding applications.

Environmental Impact: The environmental impact of radioactive isotopes used in atomic batteries, particularly in the event of accidents or malfunctions, necessitates rigorous assessments and mitigation strategies to prevent potential ecological harm.

Regulatory Compliance: The deployment and use of atomic batteries require adherence to stringent regulatory frameworks and safety standards, adding logistical and compliance considerations to their implementation. Despite the inherent challenges and considerations associated with atomic batteries, their unique advantages and resilience continue to position them as pivotal power sources in domains where traditional energy solutions fall short, driving ongoing advancements and innovations in the realm of sustainable and autonomous power generation.

Scientists Combine Lab-Grown Brain Tissues With Computer, Test Speech Recognition

This research paves the way for potential advancements in bio-computing, hinting at the prospect of more efficient systems.

In the ever-evolving quest to create artificial minds, scientists have taken a groundbreaking step: they've connected clusters of human brain cells grown in the lab (called "brain organoids") to computer chips, enabling them to perform basic tasks like recognizing spoken words. This marks a remarkable new frontier in bio-computing, potentially paving the way for computers that work more like the human brain and even surpass traditional machines in efficiency. The team created a brain organoid from stem cells, integrated it with a computer chip, and linked the system, dubbed Brainoware, to an AI tool. The hybrid setup exhibited the ability to process, learn, and retain information, showcasing rudimentary speech recognition capabilities.

"This is a first demonstration of using brain organoids [for computing]," says Feng Guo at Indiana University Bloomington. "It's exciting to see the possibilities of organoids for biocomputing in the future." Published in Nature Electronics, this research paves the way for potential advancements in bio-computing, hinting at the prospect of more efficient systems compared to traditional computers.

As per the published research paper, brain-inspired computing hardware aims to emulate the structure and working principles of the brain and could be used to address current limitations in artificial intelligence technologies. However, brain-inspired silicon chips are still limited in their ability to fully mimic brain function, as most examples are built on digital electronic principles. Brainoware is "*a bridge between AI and organoids,"* Mr Guo said. "Organoids are like 'mini-brains." "We wanted to ask the question of whether we can leverage the biological neural network within the brain organoid for computing. This is just proof-of-concept to show we can do the job," Mr Guo said.

Loneliness A Global Health Threat, As Deadly As Smoking 15 Cigarettes A Day: WHO

WHO has recognized loneliness as a serious global health threat, and it has launched a number of initiatives to address the problem.

ScienceEdited by Nikhil PandeyUpdated: November 16, 2023 4:07 pm IST

Loneliness is a serious problem, with far-reaching consequences for both mental and physical well-being. Loneliness is associated with an increased risk of a range of health problems, including mental health problems like depression, anxiety, and suicide and physical health problems like an increased risk of heart disease, stroke, dementia, and premature death. Also, loneliness can lead to social isolation and withdrawal from activities and relationships. Now, the World Health Organization (WHO) has recognized loneliness as a serious global health threat, and it has

launched a number of initiatives to address the problem. The WHO is also working with countries to develop and implement national strategies to address loneliness.

The WHO has published a report titled *"Our Epidemic of Loneliness and Isolation,"* in which it states that loneliness is far more than just a bad feeling-it harms both individual and societal health. It is associated with a greater risk of cardiovascular disease, dementia, stroke, depression, anxiety, and premature death."

New Study Reveals Surprising Link Between Exercise and Brain Size

A recent international study has unveiled an interesting connection between regular exercise and improved brain health.

Science Edited by Nikhil Pandey Updated: January 02, 2024 2:03 pm IS

A recent study by researchers from the Pacific Neuroscience Institute Brain Health Center and Washington University in St Louis discovered a strong connection between regular exercise and the size of crucial brain regions linked to memory and learning. Analyzing MRI scans of 10,125 people, the study revealed that even modest physical activity, like taking fewer than 4,000 steps a day, had a positive impact on the brain. Those who walked or ran showed larger volumes in areas responsible for decision-making and memory. This implies that setting achievable exercise goals, such as walking, can significantly benefit cognitive health by influencing key brain regions.

The research, detailed in the paper "Exercise-Related Physical Activity Relates to Brain Volumes in 10,125 Individuals," was published this week in the Journal of Alzheimer's Disease."Our research supports earlier studies that show being physically active is good for your brain. Exercise not only lowers the risk of dementia but also helps in maintaining brain size, which is crucial as we age," said Cyrus A Raji, M.D., the lead researcher, explaining the findings in simple terms.

We found that even moderate levels of physical activity, such as taking fewer than 4,000 steps a day, can have a positive effect on brain health. This is much less than the often-suggested 10,000 steps, making it a more achievable goal for many people," said David Merrill, MD, study co-author and director of the PBHC.

Study co-author Somayeh Meysami, MD, assistant professor of neurosciences at Saint John's Cancer Institute and the Pacific Brain Health Center, noted, "Our research links regular physical activity to larger brain volumes, suggesting neuroprotective benefits. This large sample study furthers our understanding of lifestyle factors in brain health and dementia prevention."

Falling in love changes our brain, finds new study

A new study has found that falling in love can change the way your brain works, making you put your loved one on a pedestal.

The study investigated the link between romantic love and the human brain. (Pexels)

We already know that being in love changes the brain by releasing the so-called “love hormone” **oxytocin**. A new study has found out that when we are in love, our brain reacts differently,

making the object of our affections the centre of our lives. Researchers from the Australian National University (ANU), the University of Canberra and the University of South Australia (UniSA) worked together to measure how a part of the brain is responsible for putting our loved one on a pedestal when we fall in love. The study published in the journal "Behavioral Science" investigated the link between the human brain's "behavioural activation system" and romantic love.

To study that, researchers surveyed 1,556 young adults who identified as "being in love.""We actually know very little about the evolution of romantic love. As a result, every finding that tells us about romantic love's evolution is an important piece of the puzzle that's just been started. It is thought that romantic love first emerged some five million years ago after we split from our ancestors, the great apes. We know the ancient Greeks philosophised about it a lot, recognising it both as an amazing as well as traumatic experience. The oldest poem ever to be recovered was in fact a love poem dated to around 2000 BCE," said study lead Adam Bode in a press statement.

According to the researchers, the way that loved ones take on special importance has something to do with *oxytocin combining with dopamine*, which is another chemical that human brains release during romantic love. Basically, love activates pathways in our brain associated with positive feelings.

Love, Actually: The science behind lust, attraction, and companionship

by Katherine Wu, figures by Tito Adhikary

In 1993, Haddaway asked the world, "What is Love?" I'm not sure if he ever got his answer – but today, you can have yours. Scientists in fields ranging from anthropology to neuroscience have been asking this same question (albeit less eloquently) for decades. It turns out the *science behind love is both simpler and more complex than we might think.* Google the phrase *"biology of love"* and you'll get answers that run the gamut of accuracy. Needless to say, the scientific basis of love is often sensationalized, and as with most science, we don't know enough to draw firm conclusions about every piece of the puzzle. What we do know, however, is *that much of love can be explained by chemistry.* So, if there's really a "formula" for love, what is it, and what does it mean? Total Eclipse of the Brain.

Think of the last time you ran into someone you find attractive. You may have stammered, your palms may have sweated; you may have said something incredibly asinine and tripped spectacularly while trying to saunter away (or is that just me?). And chances are, your heart was thudding in your chest. It's no surprise that, for centuries, people thought love (and most other emotions, for that matter) arose from the heart. As it turns out, *love is all about the brain – which, in turn, makes the rest of your body go haywire.* According to a team of scientists led by Dr. Helen Fisher at Rutgers, romantic love can be broken down into three categories: lust, attraction, and attachment. Each category is characterized by its own set of hormones stemming from the brain (Table 1).

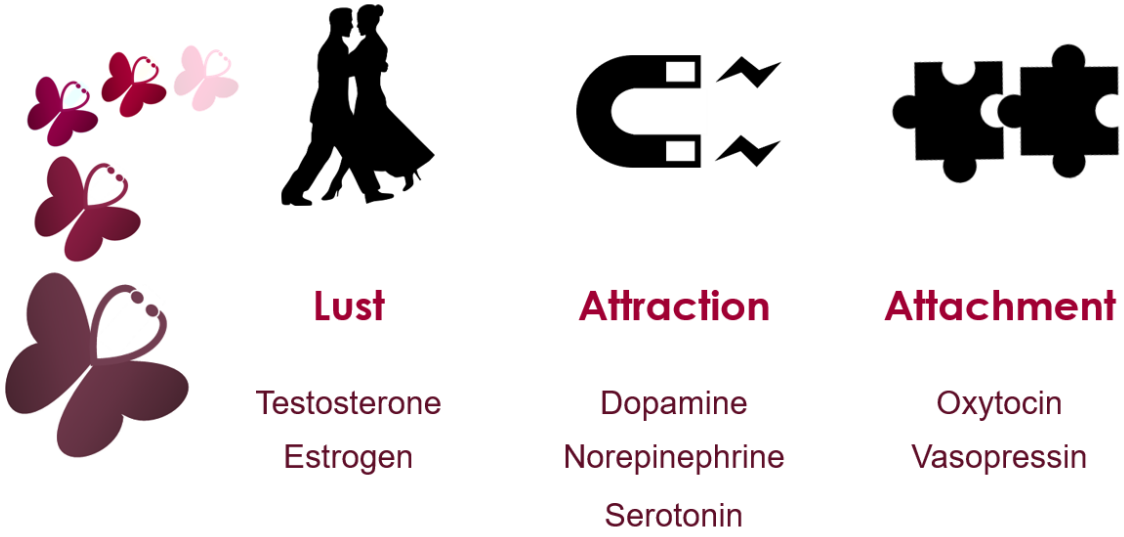


Table 1: Love can be distilled into three categories: lust, attraction, and attachment. Though there are overlaps and subtleties to each, each type is characterized by its own set of hormones. Testosterone and estrogen drive lust; dopamine, norepinephrine, and serotonin create attraction; and oxytocin and vasopressin mediate attachment.

Let's Get Chemical

Lust is driven by the desire for sexual gratification. The evolutionary basis for this stems from our need to reproduce, a need shared among all living things. Through reproduction, organisms pass on their genes, and thus contribute to the perpetuation of their species. The hypothalamus of the brain plays a big role in this, stimulating the production of the sex hormones testosterone and estrogen from the testes and ovaries (Figure 1). While these chemicals are often stereotyped as being "male" and "female," respectively, both play a role in men and women. As it turns out,

testosterone increases libido in just about everyone. The effects are less pronounced with estrogen, but some women report being more sexually motivated around the time they ovulate, when estrogen levels are highest.

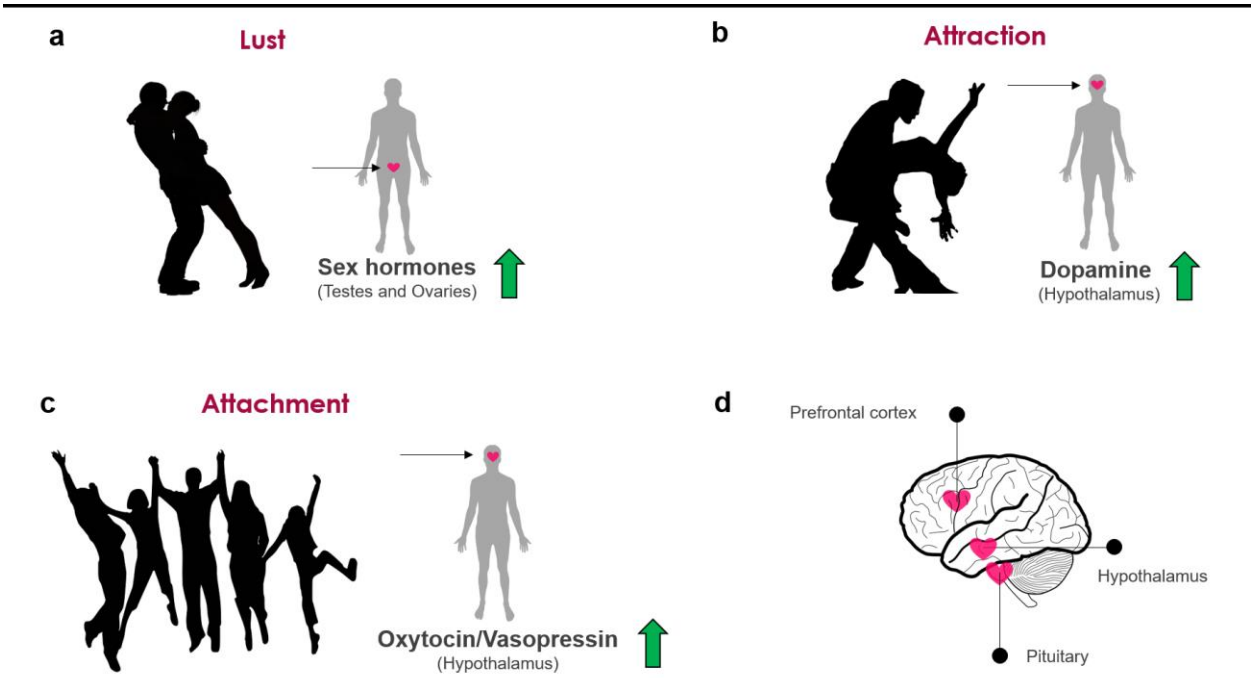


Figure 1: A: The testes and ovaries secrete the sex hormones testosterone and estrogen, driving sexual desire. B and C: Dopamine, oxytocin, and vasopressin are all made in the hypothalamus, a region of the brain that controls many vital functions as well as emotion. D: Several of the regions of the brain that affect love. Lust and attraction shut off the prefrontal cortex of the brain, which includes rational behavior.

Love is its Own Reward

Meanwhile, attraction seems to be a distinct, though closely related, phenomenon. While we can certainly lust for someone we are attracted to, and vice versa, one can happen without the other. Attraction involves the brain pathways that control "reward" behavior (Figure 1), which partly explains why the first few weeks or months of a relationship can be so exhilarating and even all-consuming.

Dopamine, produced by the hypothalamus, is a particularly well-publicized player in the brain's reward pathway – it's released when we do things that feel good to us. In this case, these things include spending time with loved ones and having sex. High levels of dopamine and a related hormone, norepinephrine, are released during attraction. These chemicals make us giddy, energetic, and euphoric, even leading to decreased appetite and insomnia – which means you

actually can be so “in love” that you can’t eat and can’t sleep. In fact, norepinephrine, also known as noradrenalin, may sound familiar because it plays a large role in the fight or flight response, which kicks into high gear when we’re stressed and keeps us alert. Brain scans of people in love have actually shown that the primary “reward” centers of the brain, including the ventral tegmental area and the caudate nucleus, **fire like crazy** when people are shown a photo of someone they are intensely attracted to, compared to when they are shown someone they feel neutral towards (like an old high school acquaintance).

Finally, attraction seems to lead to a reduction in serotonin, a hormone that’s known to be involved in appetite and mood. Interestingly, people who suffer from obsessive-compulsive disorder also have low levels of serotonin, leading scientists to speculate that this is what underlies the overpowering infatuation that characterizes the beginning stages of love.

The Friend Zone

Last but not least, attachment is the predominant factor in long-term relationships. While lust and attraction are pretty much exclusive to romantic entanglements, attachment mediates friendships, parent-infant bonding, social cordiality, and many other intimacies as well. The two primary hormones here appear to be **oxytocin and vasopressin** (Figure 1).

Oxytocin is often nicknamed “***cuddle hormone***” for this reason. Like dopamine, oxytocin is produced by the hypothalamus and released in large quantities during sex, breastfeeding, and childbirth. This may seem like a very strange assortment of activities. not all of which are necessarily enjoyable, but the common factor here is that all of these events are precursors to bonding. It also makes it pretty clear why having separate areas for attachment, lust, and attraction is important: we are attached to our immediate family, but those other emotions have no business there (and let’s just say people who have muddled this up don’t have the best track record).

Love Hurts

This all paints quite the rosy picture of love: hormones are released, making us feel good, rewarded, and close to our romantic partners. But that can’t be the whole story: love is often accompanied by jealousy, erratic behavior, and irrationality, along with a host of other less-than-positive emotions and moods. It seems that our friendly cohort of hormones is also responsible

for the downsides of love. Dopamine, for instance, is the hormone responsible for the vast majority of the brain's reward pathway and that means controlling both the good and the bad. We experience surges of dopamine for our virtues and our vices. In fact, the dopamine pathway is particularly well studied when it comes to addiction. The same regions that light up when we're feeling attraction light up when drug addicts take cocaine and when we binge eat sweets. For example, cocaine maintains dopamine signaling for much longer than usual, leading to a temporary "high." In a way, attraction is much like an addiction to another human being. Similarly, the same brain regions light up when we become addicted to material goods as when we become emotionally dependent on our partners (Figure 2). And addicts going into withdrawal are not unlike love-struck people craving the company of someone they cannot see

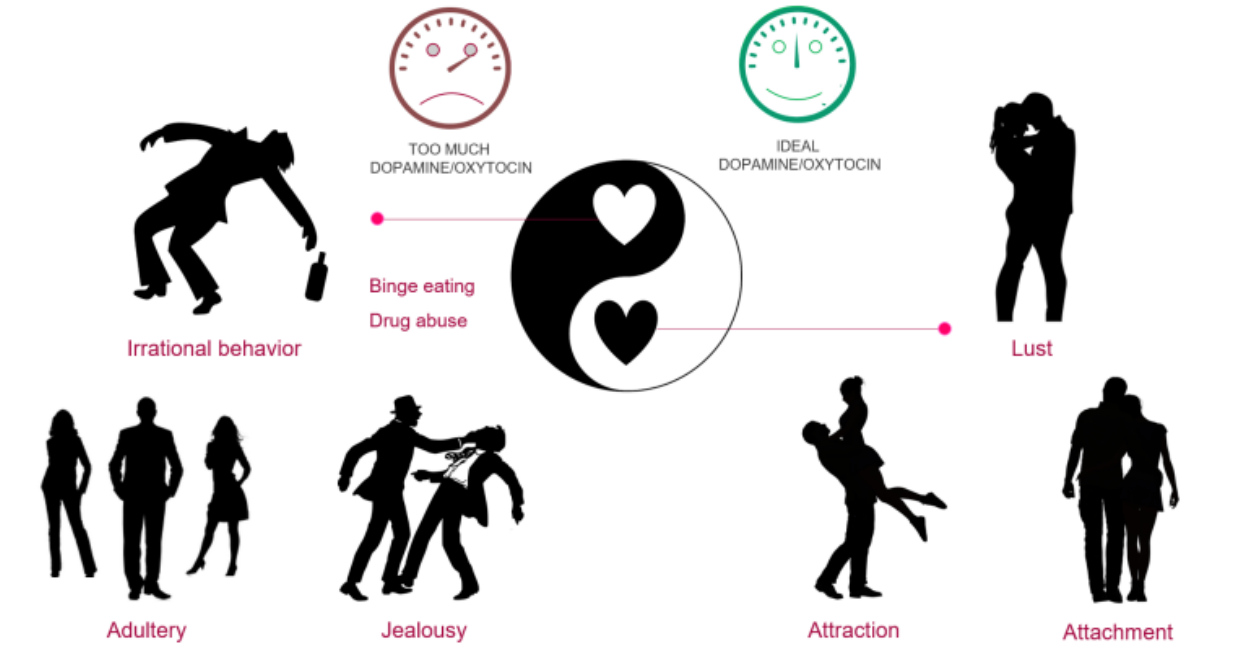


Figure 2: Dopamine, which runs the reward pathways in our brain, is great in moderate doses, helping us enjoy food, exciting events, and relationships. However, we can push the dopamine pathway too far when we become addicted to food or drugs. Similarly, too much dopamine in a relationship can underlie unhealthy emotional dependence on our partners. And while healthy levels of oxytocin help us bond and feel warm and fuzzy towards our companions, elevated oxytocin can also fuel prejudice.

The story is somewhat similar for oxytocin: *too much of a good thing can be bad*. Recent studies on party drugs such as MDMA and GHB shows that oxytocin may be the hormone behind the

feel-good, sociable effects these chemicals produce. These positive feelings are taken to an extreme in this case, causing the user to dissociate from his or her environment and act wildly and recklessly. Furthermore, oxytocin's role as a "bonding" hormone appears to help reinforce the positive feelings we already feel towards the people we love. That is, as we become more attached to our families, friends, and significant others, oxytocin is working in the background, reminding us why we like these people and increasing our affection for them. While this may be a good things for monogamy, such associations are not always positive. For example, oxytocin has also been suggested to play a role in ethnocentrism, increasing our love for people in our already-established cultural groups and making those unlike us seem more foreign (Figure 2). Thus, like dopamine, oxytocin can be a bit of a double-edged sword.

And finally, what would love be without embarrassment? Sexual arousal (but not necessarily attachment) appears to turn off regions in our brain that regulate critical thinking, self-awareness, and rational behavior, including parts of the prefrontal cortex (Figure 2). In short, love makes us dumb. Have you ever done something when you were in love that you later regretted? Maybe not. I'd ask a certain star-crossed Shakespearean couple, but it's a little late for them. So, in short, there is sort of a "formula" for love. However, it's a *work in progress*, and there are many questions left unanswered. And, as we've realized by now, it's not just the hormone side of the equation that's complicated. Love can be both the best and worst thing for you .It can be the thing that gets us up in the morning, or what makes us never want to wake up again. I'm not sure I could define "love" for you if I kept you here for another ten thousand pages. In the end, everyone is capable of defining love for themselves. And, for better or for worse, if it's all hormones, maybe each of us can have "chemistry" with just about anyone. But whether or not it goes further is still up to the rest of you.

Happy Valentine's Day!

Katherine Wu is a third-year graduate student at Harvard University. She loves science with all of her brain.

5 Reasons we must Embrace Nuclear Energy in the Fight Against Climate Change

17 January, 2024 | by Rafael Mariano Grossi (Director General, IAEA)

Source website link: https://www.weforum.org/agenda/2024/01/nuclear-energy-transistion-climate-change/

This article is part of:
World Economic Forum Annual Meeting

- At COP28, the world recognized the need to transition away from fossil fuels and reach net zero carbon emissions by 2050.
- To do that, nuclear energy is essential — nuclear power plants produce no carbon emissions, are safer than almost every other option and produce affordable energy over the best part of a century.
- Here's why nuclear energy is so important to the world — and how we can overcome investment barriers to make the most of it.

A little more than a month ago, the president of COP28 brought down the gavel on a global agreement to transition away from fossil fuels in an attempt to reach net

zero carbon emissions by2050. The meeting's host was the United Arab Emirates. In the past five years, through its investment in renewables and nuclear energy, the UAE has added more clean energy per capita to its energy mix than any other country.

Its Barakah Nuclear Power Plant started commercial operations in 2021. It will decarbonize a quarter of the Emirate's electricity grid. Globally, nuclear energy is also playing a key role in the transition to net zero. Fears about nuclear are slowly giving way to fact-based understanding. This year, for the first time, the document agreed at COP backed nuclear energy investment among low-emissions technologies.

One of nuclear's key attributes is its energy intensity. A thimblesized pellet of uranium produces as much energy as almost 3 barrels of oil, more than 350 cubic metres of natural gas and about half a tonne of coal.

5 reasons we cannot ignore nuclear energy

Nuclear power, which has 20,000 reactor years of experience across the world, has five distinct advantages.

1. From cradle to grave, nuclear energy has the lowest carbon footprint and needs fewer materials and less land than other electricity source. For example, to produce one unit of energy, solar needs more than 17 times as much material and 46 times as muchland.

2. Uranium in the earth's crust and oceans is more abundant than gold, platinum and other rare metals. It is going to take us about 100 to 150 years to get through the uranium resources we deem economically recoverable today.

3. Nuclear power doesn't rely on the weather. Well-run nuclear power plants, including for example those in the US, operate at least two to three times as reliably for two to three times as many years as intermittent low-carbon sources.

As a flexible base load for wind and solar that provides more energy when it is needed and less when it is not, nuclear power plants displace coal and enable renewables.

4. Each year, nuclear power plants produce a quarter of the world's low-carbon electricity, saving many lives that would otherwise be cut short by the lethal pollution fossil fuels pump into the air. Nuclear energy is about as safe as solar. It is far safer than coal, gas and oil, and safer than almost every other alternative energy source.

5. It is true that spent fuel is highly radioactive and emits heat. But it is also relatively compact, and extremely carefully managed and regulated. Nuclear energy generation is so efficient that the amount of all spent fuel ever produced would ,in theory , fit into 42 Olympic-sized swimming pools. Today, it is carefully stored in pools and dry storage systems or recycled. Countries like Finland and Sweden are close to putting into place deep geological repositories to dispose of spent fuel. France is also progressing in the implementation of a deep geological repository for high-level waste from spent fuel recycling.

Nuclear is one of the safest, cleanest, least environmentally burdensome and — ultimately, over the lifetime of a nuclear power plant — one of the cheapest sources of energy available. But for all of nuclear energy's positive attributes, there are hurdles to overcome. The accidents at Chernobyl and at the Fukushima Daiichi Nuclear Power Station left long shadows of mistrust and underinvestment. The upfront cost of building a nuclear power plant is considerable and budget overruns and long delays have made it more difficult to gain support for new construction.

Three levers to catalyze investment in nuclear energy

Three main levers will need to be pulled if we are to triple today's investment levels and build the nuclear capacity that will help get us to net zero.

Lever 1: Nuclear must be acknowledged for what it is: a reliable, scalable, safe and highly affordable low-carbon source of energy. It must be treated that way when it comes to investment incentives. Today's energy markets are not the same as those of the 1970s and 1980s. Nuclear needs private investment, even in markets where governments still take on much of the financing. Governments need to shoulder the risk of the high capital costs at the start. But that alone is not enough. They need to attract private financing through assured revenues and an enabling investment environment over the longer term. That means levelling the playing field nationally and internationally, including by changing the policies preventing investment in nuclear energy by many key international financial institutions and development banks.

Lever 2: Governments and the public are again turning towards nuclear. The nuclear industry needs to respond to the challenge and opportunity of this unique moment by delivering on time and on budget, while achieving a greater level of industrial standardization and better incorporating safety, security and safeguards at the design stage.

Lever 3: Regulators need to meet the moment by enabling the necessary tripling of capacity while maintaining high levels of safety. This includes building their own internal capacity, including to license the next generation of innovative reactors for which regulators do not yet have experience.

Nuclear energy is a cross-border endeavour. That means all these efforts require international cooperation and collaboration. As the centre of the global nuclear field, the IAEA will continue to facilitate progress in safety and security and enable the timely deployment of small modular reactors by bringing together regulators and industry through its Nuclear Harmonization and Standardization Initiative. Nuclear energy is an extraordinary asset whose full potential we need to untap if we are to keep climate change in check. Thenarrative that pits nuclear

against wind and solar is wrong. It is time for the truth to get through, for leaders to pull the necessary levers and help make the global climate goals achievable.

Drinking 3 Cups Of Tea A Day Could Slow Down Ageing, Study Finds

The researchers noted that the study was merely "observational," so they couldn't prove if drinking tea slowed biological ageing.

Science Edited by Bhavya Sukheja Updated: January 26, 2024 8:00 am IST

Drinking three cups of tea a day could extend your life, according to a study published in The Lancet Regional Health - Western Pacific. Researchers from Sichuan University in Chengdu, China, surveyed 5,998 British people aged 37 to 73 in addition to 7,931 people in China between the ages 30 and 79 regarding their tea-drinking habits. They found that consistent tea drinkers showed signs of slower ageing. Most of those people were male, ate a healthier diet, consumed alcohol and were less likely to experience anxiety and insomnia.

For the study, participants were asked whether they drank black, green, yellow or traditional Chinese oolong tea, as well as how many cups of it they drank daily. Researchers then calculated each participant's biological age by compiling their body fat percentage, cholesterol and blood pressure.

"The relationship suggested that consuming around three cups of tea, or 6 to 8 grams of tea leaves per day, may offer the most evident anti-ageing benefits," the authors wrote, as per

Newsweek. "Moderate tea consumption exhibited the strongest anti-ageing benefits among consistent tea drinkers," they concluded.

However, the researchers noted that the study was merely "observational," so they couldn't prove if drinking tea slowed biological ageing. Participants who stopped drinking tea appeared to show an increase in ageing, the study found.

On Camera: Scientists Capture Plants "Talking" To Each Other For The First Time

To capture the communication, these scientists used an air pump connected to a container of leaves and caterpillars, and another box with Arabidopsis thaliana, a common weed from the mustard family.

Science Edited by Amit Chaturvedi Updated: January 23, 2024 2:31 pm IS

A team of scientists from Japan has made an incredible discovery, capturing real-time footage of plants "talking" to each other. According to Science Alert, plants are surrounded by fine mist of airborne compounds that they use to communicate. These compounds are like smells and warn plants of danger nearby. The video recorded by the Japanese scientists has revealed how plants receive and respond to these aerial alarms. This significant achievement, led by molecular biologist Masatsugu Toyota from Saitama University, was published in the journal Nature Communications.

If plants could talk, they'd do so thru chemical signals about predators (aphids, caterpillars, gardeners with shears/pesticides…). Plants CAN talk (which we've known), but molecular biologists at Saitama University in Japan caught it 1st on film.

Other members of the team included Yuri Aratani, a PhD student, and Takuya Uemura, a postdoctoral researcher. The team observed how an undamaged plant responded to volatile organic compounds (VOCs) released by plants damaged by insects or otherwise. "Plants perceive VOCs released by mechanically or herbivore-damaged neighbouring plants and induce various defence responses. Such interplant communication protects plants from environmental threats," the authors said in the study. To capture the communication, these scientists used an air pump connected to a container of leaves and caterpillars, and another box with Arabidopsis thaliana, a common weed from the mustard family. Science Alert said that caterpillars were allowed to feed on leaves cut from tomato plants and Arabidopsis thaliana, and the researchers captured the responses of a second, intact, insect-free Arabidopsis plant to those danger cues.

The researchers had added a biosensor that glowed green and calcium ions were detected. Calcium signalling is something human cells also use to communicate. As seen in the video, the undamaged plants received the messages of their injured neighbours, and responded with bursts of calcium signalling that rippled across their outstretched leaves. "We have finally unveiled the intricate story of when, where, and how plants respond to airborne 'warning messages' from their threatened neighbours," Mr Toyota said.

Analysing the airborne compounds, researchers found that two compounds called Z-3-HAL and E-2-HAL induced calcium signals in Arabidopsis. "This ethereal communication network, hidden from our view, plays a pivotal role in safeguarding neighbouring plants from imminent threats in a timely manner," the researcher added. The team used a similar technique to measure calcium signals released by Mimosa pudica (touch-me-not) plants, which quickly move their leaves in response to touch, to avoid predators.