

ENERGY**Opportunities and Challenges of Green Hydrogen in India**

India is making strides in embracing green hydrogen as a promising alternative fuel, evident from the Ministry of New and Renewable Energy's Rs 496 crore scheme supporting pilot projects.

Definition of Green Hydrogen:

- Green hydrogen is produced through a process called electrolysis, where water is split into hydrogen and oxygen using renewable energy sources such as solar or wind power.
- In August 2023, the Union Ministry of New & Renewable Energy, Government of India, provided a definition for green hydrogen, specifying it as having a well-to-gate emission (encompassing water treatment, electrolysis, gas purification, drying and compression of hydrogen) not exceeding 2 kg CO₂ equivalent per kg H₂. In contrast, grey hydrogen (produced using fossil fuels), on average, emits 10 kg of CO₂ per kg of H₂ produced.
- There are five shades of hydrogen e.g. green, blue, turquoise, grey, brown

Nodal Agency: The Bureau of Energy Efficiency (BEE) (under the Union Ministry of Power) is the nodal authority responsible for accrediting agencies for monitoring, verifying and certifying green hydrogen production projects.

Initiatives for Green Hydrogen:

1. Oil India Limited (OIL) recently commissioned India's first 99% pure green hydrogen plant in eastern Assam's Jorhat
2. NTPC (in Kawas, Surat) has started India's 1st Green Hydrogen Blending operation in the Piped Natural Gas (PNG) Network.
3. The Petroleum and Natural Gas Regulatory Board (PNGRB) has given approval for a 5% blending of green hydrogen with PNG (later to be scaled to 20%)
4. Pune Municipal Corporation (PMC) has collaborated with business management consultant
5. The Green Billions (TGBL) to manage its waste and generate it into useable green hydrogen (under the waste-to-hydrogen project)
6. Strategic Clean Energy Partnership (SCEP) to mobilise finance and speed up green energy development
7. The Union Minister of Petroleum & Natural Gas launched India's inaugural Green Hydrogen Fuel Cell Bus in New Delhi in September 2023.

Significance of Green Hydrogen energy:

- **Emission reduction:** IEA (International Energy Agency) points out, that the method of obtaining green hydrogen would save the 830 million tonnes of CO₂ that are emitted annually when Hydrogen is produced using fossil fuels.
- **Viable alternative:** With green hydrogen, if the production costs fall by 50% by 2030, it could certainly evolve as one of the fuels of the future. Also, hydrogen is easy to store, which allows it to be used subsequently for other purposes and at times other than immediately after its production.
- **Energy Security and Independence:** As fossil fuels are finite and susceptible to global supply fluctuations, green hydrogen fosters energy independence.
- **Creating New Industries and Jobs:** According to IRENA, the green sector employed 11 million people in 2018, with projections of over 42 million jobs by 2050.
- **Decarbonizing Difficult-to-Decarbonize Sectors:** Sectors like heavy industry and aviation, hard to decarbonize, can benefit from green hydrogen substitution. This helps mitigate their significant carbon emissions.

Applications of Green Hydrogen:**Agriculture Sector**

- Green hydrogen can replace traditional fertilizers in agriculture by producing carbon-free ammonia.
- Ammonia production currently relies on fossil fuels, but green ammonia offers improved efficiency and reduced soil acidity.
- Green hydrogen-powered farm machinery, such as tractors and harvesters, can reduce greenhouse gas emissions in agriculture.

Water Management

Green hydrogen can power desalination plants, converting saltwater into freshwater for sustainable water management.

Transport Sector

Hydrogen fuel cells in vehicles produce zero emissions and offer a longer range and faster refuelling compared to battery electric vehicles.

Industrial Sector

- Green hydrogen production using excess renewable energy can reduce energy costs and promote sustainable development.

- On-site production and storage make green hydrogen a reliable energy source, reducing dependence on the electricity grid.
- Green hydrogen production from waste materials like municipal solid waste and agricultural waste can reduce waste and promote sustainability.
- Using green hydrogen to power fuel cells increases energy efficiency compared to traditional combustion engines, reducing overall energy consumption.

Challenges in Green Hydrogen Production:

- **Not Sufficient:** Green hydrogen constitutes less than 1 per cent of the world's hydrogen production and usage (as per the Global Hydrogen Review 2023 by the IEA). Green hydrogen production needs to grow significantly to align with Net Zero Emissions goals.
- **Energy Inefficient:** 30% of renewable energy is lost while producing hydrogen
- **Carbon Emissions:** Existing methods involve fossil fuels with high carbon emissions.
- **Low Adoption:** Low-emission hydrogen adoption in various sectors is slow.
- **Economic Sustainability:** Low economic sustainability of extracting green hydrogen. For transportation fuel cells, hydrogen must be cost-competitive with conventional fuels and technologies on a per-mile basis
- **Access to Critical Minerals** Access to critical minerals such as nickel, platinum group metals and rare earth metals could hinder scaling up electrolyser manufacturing capability in India
- **Safety Issues:** Green hydrogen is highly flammable, requiring specialized handling and storage. Establishing safety protocols and regulations is essential for ensuring its safe management.

Government Initiatives for Bio and Green Hydrogen:

1. **Global Biofuel Alliance:** Leading efforts to establish global standards for hydrogen from biomass.
2. **National Hydrogen Mission:** Targeting a production increase to 5 million metric tonnes (MMT) by 2030, meeting 40% of domestic requirements.
3. **Production Linked Incentive (PLI) Scheme:** Proposing a Rs 15,000-crore PLI scheme for electrolysers.
4. **Green Hydrogen Mission:**
 - Development of Green Hydrogen Production Capacity of at least 5 MMT (Million Metric Tonne) per annum; Renewable energy capacity addition of about 125 GW in the country by 2030.
 - **Strategic Interventions for Green Hydrogen Transition (SIGHT):** Funding domestic electrolyser manufacturing and green hydrogen production.
 - **Green Hydrogen Hubs:** Identifying and developing states/regions for large-scale hydrogen production/utilization.
 - **Strategic Hydrogen Innovation Partnership (SHIP):** Under this Public-private partnership framework R&D will be facilitated under the mission.
5. **International Collaboration:** Actively partnering with other countries, research institutions, and private entities for expertise and technology development.
6. **Renewable Energy Integration:** Integrating green hydrogen production with India's expanding renewable energy capacity for improved efficiency and sustainability.

The Ministry of New and Renewable Energy (MNRE) (In collaboration with the Ministry of Road Transport & Highways) in India has launched a new pilot project for the production of Green Hydrogen with the following components:

- **Funding Allocation:** Rs 496 crore allocated until 2025-26.
- **Pilot Project Support:** Focus on testing green hydrogen as a vehicle fuel.
- **Infrastructure Development:** Establishment of hydrogen refuelling stations.
- **Project Execution:** Selected company or consortium as executing agency.
- **Viability Gap Funding (VGF):** Approval by MNRE based on project appraisal.
- **Timeframe:** Completion of pilot projects within two years.

Way forward:

- **Reduce Production Cost:** Develop efficient technologies for electrolysis. Integrate green hydrogen production with renewable energy.
- **Implement Regulatory Incentives:** Offer tax credits and subsidies to promote adoption.
- **Improve Infrastructure:** Establish dedicated infrastructure and supply chains. Develop efficient and cost-effective supply chains.
- **Coordinate Among Stakeholders:** Ensure alignment of policies, standards, and regulations.
- **Raise Awareness and Capacity:** Educate potential users and producers about benefits. Demonstrate safety and feasibility in various sectors.
- **Develop skills and competencies for production and utilization.**

SOCIAL ISSUE**Youth suicide in India**

- As per the National Crime Records Bureau (NCRB) reports, 1.71 lakh people have died by suicide in 2022. The suicide rate has increased to 12.4 per 1,00,000 which is the highest rate ever recorded in India.
- As per a current review of adolescent suicides in India, the most reported risk factors were mental health problems (54%), negative or traumatic family issues (36%), academic stress (23%), social and lifestyle factors (20%), violence (22%), economic distress (9.1%) and relationship factors (9%)
- The numbers of suicides are underestimated in India due to an inadequate registration system, the lack of medical certification of death, stigma and other factors.

Reasons behind rising youth suicide rates in India

Suicide is a complex human behavior, and it is difficult to find a single causative factor. However, there are certain common triggering factors of suicides such as-

1) Young Girls-There are specific socio-cultural factors for suicide among young girls and women such as-
A) Arranged and early marriages, embracing young motherhood, low social status, domestic violence and economic dependence on men.

B) Gender-based discrimination and rigidity in gender roles are also responsible for young girls' suicides.

2) Cutting throat competition- Competitive examinations have pushed many students to the edge. There is tremendous pressure to get into colleges and disproportionate media hype around results and months of pent-up pressures and emotions, all this leads to rise in suicidal tendencies.

3) Rise in Alcohol and substance use- There has been an increase in alcohol consumption and substance abuse. They also contribute to youth suicides.

4) Role of the internet- A meta-analysis across 19 states in India found that about 20% of college students are addicted to the internet. One-third of young individuals experience cyberbullying, and within this group, one-third report suicidal tendencies. Further, teenagers who spend more than two hours a day on social media exhibit higher suicidal tendencies.

5) Role of media-The media has a strong influence on vulnerable young people. There has been a rise in sensational reporting of suicide especially after the suicide of famous actor. As a result of this, there was a significant increase in searches on Google on "how to commit suicide".

What steps can be taken to reduce suicidal tendencies among youths in India?

1) Help-seeking behavior- There is a need for encouraging help-seeking behavior among youth. They can be taught problem solving, impulse control and emotional regulation.

2) Identification of mental problems- There should be early identification of mental distress and provision of care in a youth-friendly environment.

3) Lifestyle changes- Youth can be encouraged to adopt a healthy lifestyle and maintain a good diet. They can engage in cultivating supportive friendships, yoga and meditation.

4) Role of family- There is a need to improve the family environment by reducing domestic violence and alcohol consumption.

5) Education reform-The government should undertake educational reforms such as alternative assessment methods and provisions to explore the potential of a young person.

6) Role of society-Society should play a constructive role by reducing stigma and discrimination based on caste, religion and sexuality.

7) Effective implementation of National Suicide Prevention Strategy for India- The strategy was launched with the objective of reducing suicide by 10% by 2030. It highlighted the significance of inter-ministerial collaboration between the Ministries of Health, Education, Information and Broadcasting, and Social Welfare for better outcome.

PRELIM FACT**1. Ikshvaku-era**

Recently around 3,730 lead coins were unearthed in an earthen pot at Phanigiri, a renowned Buddhist heritage site in Telangana.

- The coins, bearing an elephant symbol on the obverse and a Ujjain symbol on the reverse, are believed to belong to the Ikshvaku period.
- Phanigiri is considered an important Buddhist monastery located strategically on the hilltop, along the ancient trade route connecting the west and east coast of the Deccan.

About the Ikshvaku era:

- During the third and fourth centuries CE, the Ikshvaku dynasty ruled the eastern Krishna River valley from their capital at Vijayapuri (modern Nagarjunakonda in Andhra Pradesh).
- Also known as the Andhra Ikshvakus or the Ikshvakus of Vijayapuri, they were Shaivites following Vedic rituals, but Buddhism flourished during their reign.

- They practised both Buddhism and Brahminism, evident in their architectural projects.
- The dynasty's reign marked a period of cultural and religious growth but ended with the rise of Pallava rule.

2. Total solar eclipse

A total solar eclipse will cross North America, passing over Mexico, the United States, and Canada. This type of solar eclipse is a rare event for any particular spot.

- According to Royal Museums Greenwich, once a place on Earth witnesses a total solar eclipse, it will be about 400 years before that part sees the next one.
- A total solar eclipse is a rare event because it occurs when the Moon passes directly between the Earth and the Sun, casting a shadow on the Earth's surface.
- Total solar eclipses are infrequent because the Moon's orbit is tilted with respect to the Earth's orbit around the Sun, causing the Moon's shadow to usually pass above or below the Earth.
- Additionally, the umbra, or the darkest part of the Moon's shadow where a total eclipse is visible, covers only a small portion of the Earth's surface during each event.

Consequently, a specific location on Earth may **witness a total solar eclipse only once every 400 years.**

3. Criollo

A recent research on Criollo cattle, a breed developed in the New World from Iberian ancestors suggested that Criollo cattle possess various climate-adaptive traits, making them well-suited to survive and thrive in a warming world.

- These traits include a short, slick-hair coat for improved thermotolerance, as well as genes associated with reproduction, fertility, and disease immunity.
- Criollo cattle's ability to withstand hot weather leads to improved body weight, more efficient food production, and better animal welfare.

4. Artificial reefs

In a pioneering initiative in Maharashtra, Mumbai is preparing for the installation of 210 artificial reefs near Worli Koliwada.

- The artificial reefs, composed of recycled cement and steel, will increase the sea surface area by 50-60 square feet per module.
- They are expected to attract small and large native species, acting as a habitat and breeding ground.

An artificial reef is a human-made structure designed to replicate some characteristics of natural reefs. These structures include submerged shipwrecks, oil and gas platforms, bridges, and other offshore installations.

Materials used in their construction range from rocks and cinder blocks to limestone, steel, and concrete.

Artificial reefs enhance habitat for reef organisms like corals, fishes, and invertebrates.

They attract marine life, making them popular destinations for fishing, diving, and snorkelling, thus offering economic benefits to local communities.

5. Suvidha portal

Since the announcement of General Elections 2024, over 73,000 applications have been received on Suvidha Portal.

1. The Suvidha portal represents a technological advancement dedicated to upholding the principles of openness, fairness, and transparency in elections, ensuring a fair playing field.
2. This portal was developed by the Election Commission of India (ECI).
3. It operates on first-come-first-served basis.
4. It caters to permissions for organizing rallies, opening temporary party offices, door-to-door canvassing, video vans, helicopters, obtaining vehicle permits, distributing pamphlets.
4. It provides a convenient online system for political parties and candidates to apply for permissions at any time from anywhere. It has offline submission options also, which guarantee universal access.
5. The Suvidha portal enhances the electoral process by offering real-time tracking of applications, updates on status, and SMS notifications. This improves both efficiency and transparency.
6. It also supports the scrutiny of election expenditures by making permission data readily available. Thus it fosters greater accountability and integrity.

ANSWER WRITING

Q. Explain the key features of IoT (Internet of Things) and discuss its applications in smart cities. What challenges does it pose for data privacy?

The Internet of Things (IoT) comprises a network of physical objects embedded with sensors, software, and connectivity, enabling data collection and sharing over the internet. IoT spans from smart home devices to industrial machinery and envisions smart cities. It facilitates device communication, allowing autonomous data exchange and task execution, impacting industries like manufacturing, transportation, healthcare, and agriculture.

Key Features of the IoT technology

- **Connectivity:** IoT devices are uniquely identifiable and can communicate within the existing Internet infrastructure. For example, **home automation systems like Google Nest** integrate various household devices that can be controlled remotely via the internet.

- **Sensing:** Devices are equipped with sensors that detect and measure changes in the environment. The **Fitbit wearable device** tracks physical activity by sensing body movements and physiological data.
- **Actuation:** IoT can cause actions to happen through actuators. For instance, **smart thermostats can automatically adjust heating or cooling systems** in a house based on the data received from temperature sensors.
- **Intelligence:** IoT devices can process the data they collect and make decisions. **Smart traffic lights adjust light cycles** based on real-time traffic conditions to ease congestion.
- **Dynamic Nature:** They can be programmed to adapt to new inputs, ensuring the system is flexible and can evolve. The **adaptive traffic management system in Singapore**, for example, adjusts traffic signal timings based on continuous input from sensors that monitor traffic flow.

Applications of IoT in smart cities

The government's **Smart Cities Mission** aims to improve urban infrastructure and services in **100 cities across the country by utilising IoT and other technologies.**

- **Smart Traffic Management:** In **Pune**, the **Intelligent Traffic Management System (ITMS)** leverages IoT to monitor vehicular traffic using sensors and CCTV cameras. The data collected is used to control traffic signal cycles dynamically, minimising congestion and optimising traffic flows.
- **Water Quality Monitoring:** **Bengaluru's utility providers are deploying IoT sensors** within the water distribution network to constantly detect impurities, contamination levels; & ensuring that any deviation from the norm can be addressed immediately, safeguarding public health.
- **Pollution Tracking:** **Delhi** has established a network of **IoT-based air quality monitoring stations.** They provide real-time data on pollutants, enabling citizens to make informed decisions about their outdoor activities and aiding policymakers in formulating targeted environmental policies.
- **Energy Management:** The **Smart Grid Pilot in Puducherry** is an ambitious project using IoT to not only manage energy distribution efficiently but also to seamlessly integrate renewable energy into the grid, reducing reliance on traditional power sources and enhancing energy sustainability.
- **Public Safety:** **Hyderabad** has embraced IoT to bolster public safety, **employing a network of connected CCTV cameras** that offer real-time surveillance across key areas of the city. This acts as a deterrent to potential criminal activities and provides critical data to law enforcement agencies for maintaining law and order.
- **Healthcare Services:** This facilitates timely healthcare interventions and supports telehealth services, especially vital for elderly and rural populations. Eg: **Electronics corporation of India Ltd. (ECIL)** developed a remote monitoring system for COVID-19 patients, featuring an intelligent wearable device to measure vital parameters.
- **Infrastructure Maintenance:** IoT technology is **proposed for monitoring the health of Kolkata's bridges.** Sensors can detect and report issues like cracks or stresses, allowing for proactive maintenance, ensuring longevity, and preventing accidents.
- **Disaster Management:** **Chennai, prone to flooding, is utilising IoT sensors to develop an early warning system.** These sensors can provide real-time data on rising water levels, enabling efficient evacuation plans and resource deployment, thus mitigating the impact of floods.

Data privacy challenges posed by IoT in smart cities

- **Data Theft:** IoT devices can be entry points for cyber-attacks. An example is the **Mirai botnet, which harnessed thousands of IoT devices globally**, including IP cameras and home routers, to mount large-scale network attacks.
- **Data Aggregation and Profiling:** The combination of data from various IoT sources can lead to detailed profiling of individuals, **which might be misused for targeted advertising or discrimination**, without the individuals' knowledge.
- **Data Interception:** Unencrypted data transmission between IoT devices can be intercepted, posing privacy risks. For example, **smart metres could reveal personal habits based on energy usage patterns** if the data were intercepted.
- **Insecure Networks:** The interconnected nature of IoT devices means that a single vulnerability, **as seen in the case of the Chennai smart city project**, can compromise the entire network, leading to unauthorised access to personal data.
- **Mass Surveillance Concerns:** The extensive network of **IoT sensors and cameras in smart cities like New Delhi** can lead to the unwarranted surveillance of citizens, potentially tracking every movement and activity without their consent.

- **Data Sharing without Consent:** The tendency of smart cities to engage in partnerships with private companies can lead to the sharing of personal data without explicit consent, as witnessed in several smart city pilots across India.
- **Long-term Data Storage:** The Mumbai smart grid project collects vast quantities of energy usage data that, if stored indefinitely, could reveal detailed personal behaviour patterns over time, leading to privacy concerns.
- **Interconnected Device Vulnerability:** As Kochi explores IoT for healthcare, the interconnectedness of devices means that compromising one device can lead to cascading privacy issues across the network, exposing sensitive health data.
- **Opaque Data Processing:** In the smart city projects, it may be unclear how collected data is processed and for what specific purposes, leading to a lack of transparency and control for the individual over their own data.

Embracing IoT in smart cities offers transformative potential for urban India. By integrating advanced data privacy measures, these technologies can catalyse sustainable, efficient city living, while safeguarding personal privacy, leading to more responsive, inclusive, and empowered smart urban ecosystems.

MCQs

- Which of the following statements about green hydrogen is true?
 - Green hydrogen is produced using fossil fuels.
 - Green hydrogen production emits large amounts of greenhouse gases.
 - Green hydrogen is generated through electrolysis powered by renewable energy sources.**
 - Green hydrogen is primarily sourced from natural gas extraction.
- Which of the following statements about “Grey hydrogen” is true?
 - Grey hydrogen is produced using renewable energy sources.
 - Grey hydrogen is produced through the electrolysis of water.
 - Grey hydrogen is considered environmentally friendly due to its low carbon emissions.
 - Grey hydrogen is produced from fossil fuels using processes like steam methane reforming (SMR) without carbon capture technology.**
- Which one of the following is the nodal authority responsible for accrediting agencies for monitoring, verifying and certifying green hydrogen production projects in India?
 - Bureau of Indian Standards
 - Commission for Additional Sources of Energy
 - Bureau of Energy Efficiency**
 - Indian Renewable Energy Development Agency
- Consider the following statements regarding United Nations Human Rights Council (UNHRC):
 - It is a subsidiary body of the United Nations General Assembly.
 - It consists of 47 member states, elected by the General Assembly.
 - It is headquartered in Geneva, Switzerland.
 How many of the above statements is/are correct?
 - Only one
 - Only two**
 - All three
 - None
- The Indian archaeological site ‘Phanigiri’ was recently in the news for:
 - Discovery of ancient manuscripts
 - Unearthing of a significant prehistoric settlement
 - Identification of a lost civilization
 - Finding of historical lead coins**
- During a total solar eclipse:
 - The Moon passes between the Earth and the Sun, casting a shadow on the Earth's surface.**
 - The Earth passes between the Sun and the Moon, causing the Moon to be completely hidden from view.
 - The Sun passes between the Earth and the Moon, blocking all sunlight from reaching the Earth.
 - The Earth passes between the Moon and the Sun, resulting in a partial shadow being cast on the Earth.
- “Economic and Social Survey of Asia and the Pacific 2024” report was released by
 - IMF
 - WEF
 - UNESCAP**
 - WTO
- Consider the following statements about Kala-azar:
 - It is caused by a bacterium transmitted through contaminated water.
 - It progresses slowly and primarily affects the brain cells.
 Which of the statements given above is/are correct?
 - 1 only
 - 2 only
 - Both 1 and 2
 - Neither 1 nor 2**
- Consider the following committees :
 - The Political Affairs Committee
 - The Economic Affairs Committee
 - The Parliamentary Affairs Committee
 - The Appointments Committee
 How many of the above cabinet committees are chaired by the Prime Minister of India?
 - Only one
 - Only two
 - Only three**
 - All four
- Consider the following statements regarding the cabinet committee:
 - The constitution of India mentions the establishment of cabinet committees.
 - They were set up by the President of India.
 Which of the statements given above is/are correct?
 - 1 only
 - 2 only
 - Both 1 and 2
 - Neither 1 nor 2**