

SOLAR BASED TECHNOLOGY FOR GREEN HYDROGEN GENERATION: ENVIRONMENT

NEWS: India's solar leap to produce Green Hydrogen by splitting water molecules using only solar energy

WHAT'S IN THE NEWS?

India has developed a scalable solar-powered device to produce green hydrogen efficiently using silicon-based photoanode technology. This innovation supports India's clean energy goals under the National Green Hydrogen Mission amid challenges of cost, safety, and infrastructure.

Context and Overview

- Scientists in India have developed a new, scalable solar-powered device to produce green hydrogen directly from water using sunlight.
- This marks a significant technological advancement in India's pursuit of clean energy and decarbonisation goals.

About the New Device

- **Core Innovation:** Utilises a silicon-based photoanode with n-i-p (n-type, intrinsic, p-type) heterojunction structure.
 - **n-type:** Titanium Dioxide (TiO₂)
 - **Intrinsic (i):** Undoped Silicon (Si)
 - **p-type:** Nickel Oxide (NiO)
- **Fabrication Method:** Magnetron sputtering—a scalable, industry-ready deposition method used in semiconductor and solar industries.
- **Advantages:**
 - High conversion efficiency of solar energy into hydrogen.
 - Lower energy input compared to conventional methods.
 - High durability and stability.
 - Use of cost-effective and abundant materials.

What is Hydrogen?

- The lightest and most abundant chemical element (Symbol: H; Atomic number: 1).
- Colorless, odorless, tasteless, non-toxic but highly combustible gas.
- Constitutes ~75% of the universe's elemental mass.

What is Green Hydrogen?

- Produced by splitting water using electricity from renewable sources (like solar or wind).
- Considered completely clean and sustainable—no CO₂ emissions.
- As per MNRE guidelines, Green Hydrogen must emit no more than 2 kg CO₂ equivalent per kg H₂ during production (“well-to-gate”).

India’s Green Hydrogen Milestones

- **First Plant:** Operational at Kandla Port, Gujarat using indigenous electrolyzers.
- **Application Demonstration:** First batch of hydrogen-powered heavy-duty trucks deployed on major routes like Faridabad–Delhi NCR and Ahmedabad–Surat–Vadodara.
- **Supporting Infrastructure:** IOCL setting up hydrogen refueling stations in Pune, Faridabad, Balasore, and Vadodara.

Significance of Green Hydrogen

- **Energy Security:** Reduces India's dependence on crude oil (India is the 3rd largest oil consumer globally).
- **Industrial Decarbonisation:** Useful in steel, cement, refining, ammonia, and other hard-to-abate sectors.
- **Clean Transportation:** Suitable for fuel cell-powered vehicles, trains, and shipping.
- **Grid Balancing:** Acts as an energy storage solution for solar and wind power.

Challenges

- **Transportation Risks:** Hydrogen is inflammable and requires special handling in gaseous/liquid forms.
- **High Production Costs:** Electrolyser and electricity costs are currently high.
 - Green hydrogen: \$5.3–6.7/kg
 - Grey/Blue hydrogen: \$1.9–2.4/kg
- **Technological Risks:** Scale-up and long-term durability of new devices are yet to be proven in industrial environments.
- **Financing:** Investment risks due to early-stage technology and lack of demand aggregation.

Government Initiatives

- **National Green Hydrogen Mission (2023):**
 - Budget: ₹19,744 crore
 - Targets:
 - 5 million tonnes of annual production by 2030

- 50 MMT of CO₂ emissions avoided per year
- Attract USD 100 billion in investments
- Create over 6 lakh jobs
- **Green Hydrogen Certification Scheme:** For tracking emissions and certifying green hydrogen under verifiable standards.
- **Environmental Clearance Exemption:** MoEFCC has exempted green hydrogen/ammonia plants from clearance processes to boost ease of business.

Ports as Hydrogen Hubs

- **Identified Ports:** Kandla, Paradip, and Tuticorin to be developed as green hydrogen/ammonia production and export hubs under MoPSW.

Way Forward

- **Technology Scaling:** Pilot projects must be scaled with public-private partnerships.
- **Financial Instruments:** Viability gap funding, carbon pricing, and green bonds can support commercial deployment.
- **Domestic Manufacturing:** Indigenous production of electrolyzers and fuel cells to reduce import dependence.
- **International Collaboration:** Leverage partnerships (e.g., International Solar Alliance, Japan, Germany) for technology transfer and financing.

Conclusion

- India's breakthrough in solar-driven green hydrogen devices is a key step toward energy transition.
- However, success depends on bridging gaps in policy, technology, and infrastructure to realise India's decarbonised future.

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