

INTERNATIONAL CONFERENCE ON GREEN HYDROGEN

DAY 1

Inaugural Session

Speakers: Shri Raj Kumar Singh, Hon'ble Minister of Power & New and Renewable Energy; Mr Bhupinder S Bhalla, Secretary, MNRE; Mr Rameshwar Teli, Hon'ble Minister of State, Petroleum and Natural Gas, Labour and Employment, GoI; Prof. Ajay Kumar Sood, the Principal Scientific Advisor, GoI; Dr N Kalaiselvi, Director General, CSIR, and Secretary DSIR

Key highlights of the session:

- In the inaugural session of ICGH 2023, the Union Minister for Power, New and Renewable Energy, R.K. Singh said that Green hydrogen is going to be the future fuel in India. He urged the investors to invest in the country to manufacture the clean energy source.
- We will help you in developing (green hydrogen) projects. We will also help you with demand as well. Come and partner with us," he said.
- The investors can partner for development of electrolyzers, mechanism for transportation of green hydrogen, usage of green hydrogen in manufacturing for green steel and cement India is the biggest market in the world.
- He pointed like the field of renewable energy, India shall emerge as a leader in green hydrogen also.
- There are industries which have started working to set up 3.5 MT capacity of green hydrogen. They are engaged with various states for acquisition of land.
- We are on the cusp of a brave new world. Yet there is no common consensus on climate action. India's per capita CO2 emissions is 1/3 of the world, thanks to our simple life, he added.
- India's NDC achieved 9 years in advance; Currently 42% renewable, 182 GW out of 416; Target 50% by 2030, he highlighted.
- While delivering the welcome address Shri Bhupinder S Bhalla, Secretary, MNRE, mentioned that India's economy is growing rapidly, leading to an increase in demand for energy & resources.
- In his keynote address, Shri Rameshwar Teli, Hon'ble Minister of State, Petroleum and Natural Gas, Labour and Employment, GoI, shared valuable insights regarding the Green Hydrogen initiatives being taken to enter the commercial sectors in order to enhance the use of renewable energy.
- Prof. Ajay Kumar Sood, the Principal Scientific Advisor, GoI mentioned a draft R&D roadmap which has been announced and will be available on the website for public comments within the next 2 weeks.
- Dr N Kalaiselvi, Director General, CSIR, and Secretary DSIR concluded the inaugural session with a vote of thanks sharing her thoughts on Green Hydrogen.

Plenary Session – 1: India Perspective

Speakers: Shri Bhupinder Singh Bhalla, Secretary, MNRE and Mr. Ajay Sood, Principal Scientific Adviser (PSA), Government of India

Key highlights of the session:

Shri Bhupinder Singh Bhalla, Secretary, MNRE:

- India imports 40% energy
- Mobility and industrial production biggest consumer
- Needs diversification

Mr. Ajay Sood, Principal Scientific Adviser (PSA), Government of India:

- Draft national green hydrogen mission provides R&D roadmap
- 5 MMT green hydrogen production target by 2030
- Will attract 100 billion USD investment
- Strategic Hydrogen International Partnership (SHIP) is the way ahead

PARALLEL TECHNICAL SESSIONS 1

Session 1A: Hydrogen Production- Electrolysis and Biopathways

Speakers:

1. Mr. Vivek Bhide, Regional President, John Cockerill Group (Session Chair)
2. Prof. S Dasappa, Chair – ICER, Indian Institute of Science, Bangalore
3. Dr. Selvaraj Kaliaperumal, Catalysis Division, National Chemical Laboratory
4. Mr. Kowtham Raj, Lead – Green Technology Development, Larsen & Toubro Ltd

Key highlights of the session:

- This session dealt with the hydrogen production and related challenges. It has also tracked the ongoing technological advancement and also emphasised why hydrogen is important for India.

PROF S. DASPPA:

- India is an agro based economy and therefore we need to handle our residue.
- Biomass is a carbon dioxide neutral technology and therefore can be carbon negative.
- The social factor of biomass is that, it can support farmers, ensure employment, business opportunities, and supports distributed generation.
- The opportunities and potential which the conversion of biomass to hydrogen provides, is huge.
- Hydrogen generation cost are comparable to that of fossil fuel system.

Dr. KALIAPPERUMAL SELVARAJ:

- Aim is to "phase out the fossil fuels and mitigate climate change".
- Use the hydrogen sector to decarbonise the hard-to-electrify sectors
- Affordable electrolyser technology development is key to realising Energy transition.

- India should focus on building R&D infrastructure and testing capabilities.
- AEM seems to be a game changer in electrolyser technology.
- Incentivizing PPP mode tech development will help to fill up the "Valley of Death" in mi

Mr. KOWTHAM RAJ

- "National Green Hydrogen Mission" is an Indian government thrust on energy transition.
- India is important because, energy, manufacturing and R&D is up-to-date and advance
- Pressurised Alkaline Electrolyser technology is reliable, scalable, affordable. It saves compression cost and cost for innovation.
- Electrolyser have lot of scope to advance the technology and reduce the cost and gap.
- In last many years we have seen very very few changes in design. Designs can play a big role in reducing the cost and increasing the efficiency.
- India have a entire chain to produce low cost electrodes.

Session 1B: Hydrogen Storage, Distribution and Refuelling

Speakers:

1. Mr. Ravindra Vasisht, Independent Consultant (Session Chair)
2. Prof. Swati Neogi, Professor – Chemical Engineering, IIT Kharagpur
3. Prof. Pratibha Sharma, Department of Energy Science & Engineering, IIT Bombay
4. Mr. Puneet Khurana, Managing Director, Everest Kanto Cylinder Ltd
5. Mr. Anup S Shapeti, Hydrogen & LNG, INOX India Limited

Key highlights of the session:

- The Technical Session on "Hydrogen, Storage, Distribution, and Refuelling" on Day 1 of the ICGH 2023 deep dived into solutions to explore physical and material hydrogen storage, distribution and refuelling solutions.
- The discussion covered compressed hydrogen, liquid hydrogen, underground storage, cold gas storage, and cold compressed storage.
- The speakers shed light on the benefits, challenges, and advancements in each method, providing valuable insights to the industry.

Session 1C: Hydrogen Energy Ecosystems & Assessment

Speakers:

1. Mr. Aashish Maheshwari, Associate Business Director, Evonik (Session Chair)
2. Mr. James Khong, Co-Founder and COO, Galaxy FCT
3. Mr. Kuldeep Rai, Executive Director, Rural Electrification Corporation Limited
4. Mr. Sachin Chugh, Dy. General Manager – H2 & Fuel Cell, Indian Oil Corp. Ltd.
5. Mr. Loftur Thorarinsson, Project Lead – New Energies, Mitsui O.S.K. Lines (U.K.)

Key highlights of the session:

- The Technical Session on 'Hydrogen Energy Ecosystems & Assessment' at ICGH 2023 recognised Industry's zeal in producing green hydrogen, identified areas requiring attention, and deliberated on finding a holistic approach to propel green hydrogen economy.

Session 1D: Fuel Cells & Electrolyzers: Key Materials & Components

Speakers:

1. Dr. Tata N Rao, Director, ARCI (Session Chair)
2. Dr. N Rajalakshmi, Former Senior Scientist, Centre for Fuel Cell Technology, ARCI, IIT Madras (Virtual)
3. Mr. R Balu, Head of New Projects, R&D, Thermax Ltd
4. Dr. Sreekumar Kurungot, Physical & Materials Chemistry Division, NCL

Key highlights of the session:

- The sessions discussed the key materials and components required to make green hydrogen. The moderator Dr Tata N Rao, Director, ARCI discussed some basic technologies to produce the key materials and components such as the fuel cells, different electrolyzers including the alkaline electrolyser or the PEM electrolyser.
- Dr Rajalakshmi, Senior Scientist in Centre for Fuel Cell Technology, Ex-ARCI discussed the processes for making raw materials, how to integrate them with the available hydrogen technologies and the current status while discussing the future roadmap for India hydrogen production. She pointed out about 210 million tonnes of hydrogen demand will be created by 2030 and about half of it will be coming from green sources. The use of grey hydrogen in the economy principally for fertilizer, oil refining and petrochemical production – currently accounts for around 2% of global CO₂ emissions. Clean hydrogen is the only alternative here.
- During 2019, at the time of release of the "the future of hydrogen for the G20" by IEA, only three countries, France, Japan and Korea had policies and today, 17 governments have released hydrogen strategies and many companies are trying to tap business opportunities. There also other benefits from clean hydrogen beyond decarbonization including energy resilience, unlock the full potential of renewable energy into existing systems and enhancing energy mix.
- The development of global capacity of electrolyzers, which doubles over the last five years to reach 300MW and likely upto 90 GW by 2030, and hydrogen supply from electrolyzers could reach around 8Mt by 2030. She highlighted that from the sustainability point of view, it is necessary to achieve a reduction in the use of the critical materials used in these technologies to meet the demand, easy manufacturing without loss, efficient mining, recycling, etc.
- She looked into the detailed role of fuel cells (FC) and how they can contribute significantly to sustainable and secure energy supply systems. Several FC types are today available, capable of operating under different conditions depending on the type of fuel, operation temperature and the type of electrolyte. Polymer electrolyte Membrane Fuel Cell (PEM FC) technology is the most popular type of FC.

- She also looked into the current challenges, where she said around 30 raw materials are needed for producing FCs, electrolytes and hydrogen storage technologies. Further, she also highlighted what is required to be done to overcome the current challenges such as reducing critical raw materials in electrolyzers and fuel cells. Various key opportunities were also elaborated upon, where she highlighted the need for diversifying the materials supply and recycling of FCs and hydrogen technologies.
- She concluded with spelling out a roadmap and highlighted the need for a stronger coordination among different initiatives to avoid duplication of efforts and ensure efficient progress.
- Mr R Balu from Thermax Limited elaborated on the different electrolyser systems with a detailed dive into their materials and stack components. He pointed out the current challenges of the electrolyser system such as the differing water quality in catalyst development. Looking into the different fuel cells and electrolyzers and the role they play in wider hydrogen experience, he pointed out the various projects of his company Thermax in producing green hydrogen.
- Dr Sreekumar Kurungot, CSIR-National Chemical Laboratory, Pune highlighted the initiatives and efforts by CSIR in the indigenization of producing green hydrogen. He mapped out the working of CSIR in generation of raw materials, developing storage materials and facilities and the futuristic solutions in this sector. He enumerated the key CSIR technologies on hydrogen generation and storage. One such effort has been the first hydrogen fuel cell electric hybrid car that completed its test run in Pune and India's first indigenously developed hydrogen FC Bus. He also further elaborated upon the future ambitious research programs at CSIR and their current status such as developing cost-effective catalysts and developing process-friendly electrodes which require bottom-up design strategies.

PARALLEL TECHNICAL SESSIONS 2

Session 2A: Hydrogen Production – Thermochemical Nuclear / Other

Speakers:

1. Prof. G D Yadav, Green Chemistry and Technology, ICT Mumbai (Session Chair)
2. Dr. Anjan Ray, Former Director, Indian Institute of Petroleum, Dehradun
3. Dr. Srinivas Rao, Scientific Officer, Bhabha Atomic Research Centre
4. Mr. Jasant Singh, Head, Development Department, Haldor Topsoe India

Key highlights of the session:

- This session emphasised on decarbonising the economy and therefore hydrogen becomes very important.

PROF. G.D. YADAV:

- Green hydrogen technologies play an important role in present times as we have added a lot of Carbon dioxide in our atmosphere.
- India will be the exporter of green energy by 2030.
- Government of India is giving a lot of impetus to green hydrogen.
- what we are doing with hydrogen, same thing can also be done with ammonia.

Dr. ANJAN RAY:

- India needs to reduce its energy import to decarbonise and therefore more impetus to green energy.
- Rule of thumb of sustainability; Input rule and output rule.
- India imports 330 million tonnes Carbon atoms in the year 2022. It is 6% less in comparison to the import in the year 2018.
- We need to prioritise the cost of earth over the cost of green energy.
- Energy density of hydrogen is three times more to gasoline, if we can compress the hydrogen.
- Hydrogen from Plastic is gaining rapid currency in Singapore.
- Methane is 80 times more potent than carbon dioxide.
- we need to look beyond electrolysis for green hydrogen acceleration in India.

Dr. A SHRINIWAS RAO:

- Iodine sulfur process is a three step process, including Bunsen section, HI section, Sulfuric acid section.
- High pressure Bunsen section is feasible to carryout in continuous mode.
- Hybrid- Sulfur (HyS) water splitting process is a 2 step process.
- IS and HyS process is developed with indigenous components- Participation of PSUs, Industry for higher scale plants.
- Cu-Cl process has advantage of temperature.

Mr. JASWANT SINGH

- TOPSOEs Company mission was to save the world after world war.
- TOPSOE collaborating with 40+ Universities.

Session 2B: Hydrogen in Mobility

Speakers:

1. Prof. K A Subramanian, Professor, IIT Delhi (Session Chair)
2. Mr. Ravi Pandit, Chairman & Co-Founder, KPIT Pune
3. Mr. Sadagopan Krishnan,
4. Sr. Vice President, Ashok Leyland
5. Mr. Sudeep S Dalvi,
6. Sr. VP & Director-Technical, Toyota-Kirloskar Motors

Key highlights of the session:

- The technical session on "Hydrogen in Mobility" on Day 1 of the International Conference on Green Hydrogen covered various technologies that accelerate the generation and Application of Hydrogen.
- Further discoveries included insights on carbon emissions, CNGs, and LPGs while shedding light on Alternative Fuels and advanced Vehicles, i.e., Biodiesel, Diesel, Electricity, Ethanol, Flex Fuel, Hydrogen, Fuel Cell, Natural Gas, and Renewable Diesel

Session 2C: Integrated Hydrogen Systems

Speakers:

1. Dr. J P Gupta, Managing Director, Green Hydrogen India (Session Chair)
2. Mr. Venkatesh M, Chief Technology Officer, L&T
3. Mr. Rajat Seksaria, Independent H2 Expert
4. Mr. Vishal Mehta, Managing Director & Partner, BCG

Key highlights of the session:

- The technical session on 'Integrated Hydrogen Systems' highlighted the 5 different lenses critical for the Integrated Hydrogen Systems which include production, fuel cells, tech validation, safety, codes & standards.
- The session held impactful discussions around hydrogen colour spectrum, green hydrogen in industrial sectors such as green steel, construction, transportation, etc.
- Hydrogen value chain throughout production, transport & storage and application were also discussed.

Session 2D: Hydrogen in Industries

Speakers:

1. Dr. SSV Ramakumar, Director (R&D), Indian Oil Corp. Ltd. (Session Chair)
2. Dr. Anurag Pandey, R&D Lead, Reliance Industries Limited
3. Mr. Mohit Bhargava, Chief Executive Officer, NTPC Renewable Energy Ltd
4. Mr. Sudhir Pathak, Head – Engineering, Hero Future Energies
5. Dr. Samik Nag, Chief - Iron Making Research Group, R&D Division, Tata Steel

Key highlights of the session:

- Current world hydrogen demand is 90 MMT, expected to reach 140 by 2030, represents huge opportunity. However, this 90 mmt is almost entirely grey, leaving huge carbon trail, need to make it green
- India current capacity 6 MMT, by 2030 it will touch 12
- Out of this 6, oil and gas 1.5
- Electrolysis is the most efficient production technology discovered so far and most mature
- When we are converting waste to biogas, some of this biogas can be turned into green H2.
- Panipath refinery in Northern India is developing green hydrogen facilities.

- GAIL is working on H2 transportation

Panel Discussion on Disruptive Science & Technology

Speakers:

1. Dr. N Kalaiselvi, Director General, CSIR and Secretary DSIR (Session Chair)
2. Prof. Swati Neogi, Indian Institute of Technology, Kharagpur
3. Prof. Suddhasatwa Basu, Indian Institute of Technology, Delhi
4. Prof. Pratibha Sharma, Indian Institute of Technology Bombay
5. Prof. Prakash Vaidya, Institute of Chemical Technology Mumbai
6. Prof. Uttam Kumar Ghorai, Ramakrishna Mission Vidyamandir, Kolkata
7. Dr. R Nandini Devi, Senior Principal Scientist, CSIR-National Chemical Laboratory

Key highlights of the session:

- At the Panel Discussion on Disruptive Science and Technology, Dr N Kalaiselvi, Director General, CSIR and Secretary DSIR, shared important insights for the future of Green Hydrogen. She said that the time is opportune to address the supply chain issues for green hydrogen and stressed R&D and government should prioritize sub-components and foster integrated ideas to achieve our common goals.
- Green Hydrogen Technology is the Next Disruptive Technology, and it has the power of replacing coal but for that, we need to focus on reducing the cost of Hydrogen Generation, said Prof. Swati Neogi, Indian Institute of Technology, Kharagpur while addressing the panel discussion. In her presentation she highlighted 12 disruptive technologies encompassing renewable energy, advanced oil and gas exploration, and global internet penetration.
- Prof. Suddhasatwa Basu, Indian Institute of Technology, Delhi talked about H2DC12 Mobile Biomass Converter (BMC) and the corresponding government actions which included the Green Hydrogen Study, Adoption of Electric Vehicles, MBED, GNA, Green Energy Corridors, and National Monetisation of Pipelines. Notably, his observations underscore the forthcoming high demand for hydrogen in India.
- In her remarks, Prof. Pratibha Sharma, Indian Institute of Technology Bombay highlighted the need for collaboration in creating efficient storage facilities for hydrogen-based products. She urged for Industry, academia, and government to unite their efforts.
- The catalytic cracking of methane presents an opportunity to generate hydrogen (H₂) and carbon (C) through an alternative process, pointed Dr. R. Nandini Devi, a Senior Principal Scientist at CSIR-National Chemical Laboratory in his address. He mentioned that while methane burning has traditionally been employed for hydrogen release, the exploration of new extraction methods becomes imperative. Plasma Generation, proposed by, emerges as a promising avenue worth testing for its potential in hydrogen extraction, he added.
- Prof. Uttam Kumar Ghorai, Ramakrishna Mission Vidyamandir, Kolkata initiated discussions on leveraging ammonia technology for cost-effective hydrogen production. He shed light upon the 3 generations of hydrogen production and storage using ammonia, i.e., In Generation 1, hydrogen can be stored in ammonia via the Haber-Bosch process. In

Generation 2, hydrogen can be produced through the electrolysis process, and in Generation 3, new frontiers are unlocked in advanced for the ammonia-based systems.

- 'Large teams develop and small teams disrupt science and technology', stated Prof. Prakash Vaidya, Institute of Chemical Technology Mumbai while addressing the session. In the discussion he stressed on Hydrogen as a solution provider for a greener future. He mentioned about exploring in-situ CO₂ absorption for enhanced hydrogen production that uncovers captivating possibilities.