



PHD CHAMBER OF COMMERCE AND INDUSTRY / INVEST INDIA / DET MODERNE INDIA /
NORWEGIAN HYDROGEN FORUM / ARENA H2CLUSTER / CENTER of EXCELLENCE PRESENTS:

OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA



HYBRID EVENT

BERGEN NORWAY

30th - 31st AUGUST 2022

30th August 2022

SUMMIT

31st August 2022

INDUSTRY VISITS



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President
PHDCCI



Mr. Alok B. Shriram
Former President
PHDCCI



Dr J P Gupta
Managing Director, Greenstat
Hydrogen India Pvt Ltd and Chair,
Environment Committee, PHDCCI



Mr Mahendra Rustagi
Co-Chair
Environment Committee
PHDCCI



Dr J S Sharma
Co-Chair
Environment Committee
PHDCCI



Dr C P Kaushik
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Mr Saurabh Sanyal
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Greenstat Norway



Sturle Pedersen
Chairman, Greenstat
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India Pvt Ltd



Dr Karen Landmark
Chair of the Board
Greenstat Asia AS, Bergen



Dr Knut Linnerud
CEO
Greenstat Asia AS,
Bergen



**Dr Silje Schei
Tveitdal**
Director of the Board
Greenstat Asia AS,
Bergen



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Senior Secretary
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Mr Suresh Gupta
Vice President, Unithinx
Enterprises Pvt. Ltd. and
Member, Environment
Committee, PHDCCI



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Enterprises Pvt. Ltd.



Ms Ankita Pal
Executive Officer
PHDCCI



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Organizing Committee- Greenstat Norway



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Greenstat Asia AS,
Bergen



Dr Silje Schei Tveitdal
Director of the Board
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Oda Marie Ellefsen
R&D Coordinator, Project
Manager Hydrogen, Asia



PHDCCI Delegation to Norway for the International Climate Summit 2022 led by

Mr. Alok B. Shriram

[Leader - Delegation]
Former President, PHDCCI
and Vice Chairman,
Shriram Institute for Industrial
Research

Dr. J P Gupta

[Joint Leader - Delegation]
Managing Director, Greenstat
Hydrogen India Pvt. Ltd. and
Chair, Environment Committee,
PHDCCI

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3	Dr. J P Gupta	Chair	Environment Committee, PHDCCI
4	Dr. J S Sharma	Co-Chair	Environment Committee, PHDCCI
5	Dr. Ila Sharma	w/o Dr J S Sharma	
6	Mr. Mahendra Rustagi	Co-Chair	Environment Committee, PHDCCI
7	Mrs. Babita Rustagi	w/o Mr Mahendra Rustagi	
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10	Ms Swati Pathak	w/o Mr Pathak	
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12	Mr Ashwin Kumar Wasnik	Project Coordinator	Technology Development Board, Department of Science & Technology, Government of India
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27	Mrs. Reeta Agarwal	w/o Mr Rajnish Kumar	
28	Mr. Dilip Jawale	Project Manager	Greenstat Hydrogen India Pvt Ltd
29	Mr. Umesh Sahdev	Executive Chairman	Hydrogenium Resources Pvt. Ltd.
30	Mr. Suresh Gupta	Vice President	Unithinx Enterprises



31	Mrs Madhu bala Gupta	Educationist, Member	Ekal Bharat Lok Shiksha Parishad
32	Mr. Prasad Krishna Panicker	Director & Head Of Refinery	Nayara Energy Limited
33	Mr. Jayesh Chandrakant Gajjar	Refinery - Head Operations	Nayara Energy Limited
34	Ms. Shalaka Satish Wate	Manager - CEO office	Nayara Energy Limited
35	Mr. Sanjay Sharma	Director	ECOFAY Services Pvt. Ltd.
36	Mr. Ambuj Mishra	Partner	ECOFAY Services Pvt. Ltd.
37	Dr. K. K. Pant	Chair	Professor Federation of Indian Petroleum (FIP)
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39	Mr. Rajendra Narkhede	Senior Vice President	Gexcon
40	Mr. Aakaash Kayathwal	Director	Incredobusiness
41	Dr. R. K. Malhotra	President	Hydrogen Association of India
42	Abhay Sharma	Director	A. POWER HIMALAYAS / REGENCY YAMUNA ENERGY LTD / POWER GROUP / HIMALAYA POWER PRODUCERS ASSOCIATION
43	Mr Prem Singh Dhingra	Chairman and Founder Trustee	Humanity Infinite
44	Ms Agya Kaur Dhingra	w/o Mr Dhingra	
45	Mr. Ashutosh Agrawal	Managing Director	ABN Equipments & Systems Private Limited
46	Mrs. Mahima Agrawal	Director	ABN Equipments & Systems Private Limited
47	Mr. Purvash Agrawal	Prospective Promoter	ABN Equipments & Systems Private Limited
48	Ms Barbie Agrawal	Prospective Promoter	ABN Equipments & Systems Private Limited
49	Mr. Rajeev Akshay Karthikeyan	Founder & Managing Director	Leap Green Energy Pvt Ltd
50	Mrs. NIKHILA KONERU	President – Business Development	Leap Green Energy Pvt Ltd
51	Mr. DEV ANAND V	Founder & CEO	Leap Green Energy Pvt Ltd
52	Dr. Randeep Singh Saini	Executive Director	Green Economy Initiatives Private Limited
53	Mr. Vijay Sheoran	CEO	Dalmia Healthcare Limited
54	Prof. (Mrs) Rajita Kulkarni	President	Sri Sri University
55	Mr Sampat Dhoot	Managing Director	Elgris Solar Power Systems Pvt Ltd
56	Ms. Vaishnavi Chechani	W/o Mr. Sampat Dhoot	
57	Mr. Subham Bagaria	Chief Business Officer	Seventy Three Products Trading LLC
58	Mr. Sushilkumar Bagaria	Director	Seventy Three Products Trading LLC
59	Mr. Rakesh Gupta	Senior Vice President (Strategic Planning)	JK Lakshmi Cement Limited
60	Mr. SK Wali	Not advised	JK Lakshmi Cement Limited
61	Mr. Suresh Nair	Not advised	LNJ Bhilwara Group
62	Mr. Shantanu Agarwal	Executive Director	LNJ Bhilwara Group
63	Mr. Siddharth Mayur	CMD	h2e Power Systems
64	Mr. Rahul Gautam	CMD	Sheela foam Ltd
65	Mr. Tushaar Gautam	Director	Sheela foam Ltd
66	Mr. Abhishek Bhatnagar	CEO & Director	ITEN Media Pvt Ltd
67	Mr Neeraj Gupta	Business Development Head	Envirotech instruments Pvt Ltd
68	Ms. Neena Gupta	Marketing Manager	Envirotech instruments Pvt Ltd



About the Summit

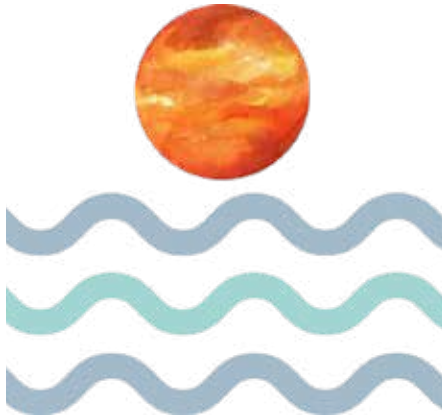
Last year PHD Chamber of Commerce and Industry jointly with Invest India and in partnership with NITI Aayog, TERI, NEERI, Ministry of Environment, Forest & Climate Change and with the support of several Ministries of Government of India and Innovation Norway as the country partner organized the 'International Climate Summit 2021- Powering India's Hydrogen Ecosystem' at Hotel Taj Palace, New Delhi on 3rd of Sep 2021. There was a high level delegation from Norway along with 35,000 participants from around the globe. Several Nobel laureates, Academicians, Policy Makers worldwide attended the summit.

A comprehensive Knowledge Portal on Hydrogen was launched by Dr. Jitendra Singh, Hon'ble Minister of State (IC) of the Ministry of Science & Technology. Also, A Knowledge Book on 'Self-Reliant India – harness the power of hydrogen' was launched by Shri Ashwini Kumar Choubey, Hon'ble Minister of State for Ministry of Environment, Forests and Climate Change.

The Summit was a resounding success and many of the key takeaways which were submitted to the Government of India were kindly accepted for Introduction of Green Hydrogen in the Country.

National Hydrogen Energy Mission (NHEM), launched in 2021, aims to aid the Government of India in meeting its climate targets and making India a green hydrogen hub. This will help in meeting the target of production of 5 million tonnes of green hydrogen by 2030 and the related development of renewable energy capacity.

This year, PHD Chamber of Commerce and Industry in partnership with Invest India along with Greenstat, Norway is organizing the International Climate Summit 2022 - Opportunities for Green Hydrogen in India on 30th and 31st August in Bergen Norway.



Key takeaways of the summit are as under

- To identify the incentives required for setting up mega scale hydrogen plants in India for domestic consumption and export.
- Opportunities for developing infrastructure to transport and store hydrogen & industrial applications for the green hydrogen being produced.
- Cost effective technologies for setting up plants for the production of hydrogen on medium and large scale.
- Opportunities for technological tie up for entire value chain of Green Hydrogen.
- R&D collaborative tie up for hydrogen production, using PAM, Alkaline, AEM and Technologies with Norwegian and European Research Labs.
- Setting up of Centre of Excellence covering process safety, mapping of available standards and policies with respect to International standards, using highly sophisticated software, training of manpower through VR and AVR in Hydrogen Production, Transportation and Applications.
- Provide pathway for energy security coupled with direction on developing road map for achieving net zero target of India.





Dr. Jeewan Prakash Gupta

Summit Chair and
Chair Environment Committee, PHDCCI

Dr. Jeewan Prakash Gupta is currently the Managing Director, Greenstat Hydrogen India Ltd.

He is also Chairman of Governing Council, Centre of Excellence in Process Safety and Risk Management at IIT Delhi.

He is also Member of Board of Governors of SRIRAM Institute of Industrial Research.

He is an adjacent Professor at ICT Mumbai.

He holds several other positions on technical bodies for production of Renewable Energy and Green Hydrogen.

West & East to Combat Climate Change

MESSAGE FROM SUMMIT CHAIR

"The Earth does not belong to man. Man belongs to the Earth. All things are connected. Like the blood that unites us all. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself." Chief Seattle

Last fall, less than three months before COP 26, the IPCC launched a landmark assessment that was the first major review of the science of climate change since 2013. The report argued, beyond any reasonable doubt, that human activity is changing the climate in unprecedented and sometimes irreversible ways. The study continued to warn of increasingly extreme heat waves, droughts and flooding, and a key temperature limit being broken in just over a decade. The report "is a code red for humanity", said the UN Secretary General António Guterres, when giving his comments to the report.

The code red for humanity is first and foremost a dire threat and a call for rapid action. Time is running out. On a more positive note, it may provide an opportunity to fundamentally change the systems that on a daily basis undermines our natural world and hence our very existence. Further, it may assist us in changing the way we think of ourselves as part of nature and all living systems. For one thing is certain, change is needed on an individual, organizational and societal level and the necessary change is deeply linked to how we perceive ourselves in the world or as part of the world. History shows us that man's relationship to nature has changed over time, yet our dependency on our eco-systems for food, water and air remains crucial.

As we know, sustainability is based on the principle that everything we need for our survival and well-being depends, directly or indirectly, on the natural environment. Hence, sustainability creates and maintains the conditions under which humans and nature can co-exist in a productive harmony. Ideally, this harmony should allow for the satisfaction of social, economic and other needs, both for the present as well as future generations. Sustainability is concerned with making sure that we have, and will continue to have, water, materials, and other basic resources that are paramount for protecting both human existence and the natural environment. In other words, sustainability is a precondition for human survival on the planet earth.



The way we perceive and relate to the world influences how we relate to sustainability: on an individual, organizational and societal level. We are deeply concerned that the speed and pace of our efforts does not match the seriousness of climate change and environmental degradation, as the global emissions keep rising alongside with global average temperatures. The global system of nature on which we all depend probably cannot support present rates of economic and population growth much beyond the year of 2100.

Urgent change is needed and to facilitate that, we need a holistic approach covering all parts of the global society. Mitigation of climate change is only possible in a just and transparent way, allowing emerging economies the chance to create good lives for their peoples. The use of energy and resources on the planet is unequally distributed and the global action on climate change in the coming years, should take this into account. In example, the average carbon footprint of the world is about 4 ton per person per annum compared to just about 0.5 ton per person per annum in India.

Global energy demand is growing, as a consequence of population growth, industrialization and increasing access to energy in the population. At the same time, the world is in a necessary and crucial energy transformation, where fossil fuels must be replaced by renewable energy and alternative energy carriers. Hydrogen is an alternative energy carrier to fossil fuels, which humans are able to produce themselves, based on renewable energy. India's advantage due to its geographical location, climate conditions and abundance of renewable sources of energy like solar, wind and hydro, make it ideal for becoming the world's cheapest hydrogen hub by 2030.

Further, we strongly believe that Ancient Wisdom can offer solutions and insights to combat climate change. Ancient wisdom can help us tap into the very essence of humanity and can assist us in seeking and embracing an environmental conscious life style that focus on mindful and deliberate utilization, instead of mindless and destructive consumption. The principles of circularity, reduce, reuse and recycle should become an integrated part of our culture and life style.

It saddens us to have to also make the connection between climate change and peace. In this very moment, world leaders talk about peace, yet they prepare for war. In fact, they say, we are preparing for war to preserve peace. Most irrational. To preserve peace, one can only prepare for peace. War is destruction, peace is creation. Peace can be achieved through spiritual and cultural transformation. By doing so, we can change our lifestyles from being greed based to becoming need based and hence support the rapid changes we need so urgently.

We hope and we believe that change is possible, but we need to act now!



Ancient Wisdom



His Holiness Sri Sri Ravi Shankar

His Holiness Sri Sri Ravi Shankar, Founder of Art of Living, is a globally revered spiritual master and peace maker. The contribution of Art of Living through its recent many initiatives to remove the sufferings of the people of Ukraine in ongoing war with Russia, has been noteworthy.

His foundation 'Art of Living' is having presence across under 56 countries and has reached an estimated 500 million people. Accredited as a United Nations non-governmental organization in 1996, Art of Living works in special consultative status with the UN's Economic and Social Council. His Holiness has also taken many initiatives to combat climate change through 'Ancient Wisdom'.

Spiritual transformation is the only Panacea for climate change.

"Since ancient times, people the world over have honored our planet and its five elements. This is how we were able to thrive on our beautiful earth all these years. It is our duty to care for our environment as our very existence depends on it."

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

INDIA - NORWAY ALLIANCE

Greenstat, Norway and PHDCCI
Joins together to make
India Self Reliant in Hydrogen Production





Vegard Frihammer

Green Executive Officer / Founder

Founder and GEO of GREENSTAT, an energy company founded to create value through green business models within local energy, hydrogen, energy analysis and other areas within renewable energy.



Karen Landmark

Chief Strategy Officer

Dr. Karen Landmark has more than 20-year experience working with sustainability issues for private sector. She holds a PHD in sustainability transitions focusing on energy transitions and effects on societies. She is part of the management at the Greenstat Group and hold the position as chair of the board for Greenstat Asia.

Greenstat welcomes ICS 2022 to Bergen, Norway

It is a great honor and pleasure for Greenstat to host this year's International Climate Summit, "Opportunities for Green Hydrogen in India", in Bergen, Norway, where Greenstat is headquartered. As a co-host with the PHD Chamber of Commerce and Industry and Invest India, we hope to follow up last year's success in New Delhi, India, with at least as much worldwide attention.

Norway is a distinct energy nation that started producing hydropower 130 years ago and with its almost 100 years of experience in the production of green hydrogen, by electrolysis. Approximately 99% of all power production in Norway today is based on renewable energy. However, just over a third of the total energy consumption in Norway is still based on fossil energy, which is mainly used in mobility and industry.

Norway has a major responsibility to be a proactive player in the transition from fossil energy to renewable energy, with its long history and access to enormous amounts of fossil energy, which today represent as much as about 40% and 60% of respectively gas and oil resources in Europe. To meet the future needs will have to take part in scaling up the global production of Green Hydrogen.

We all have a responsibility to reduce climate emissions, and thus reduce the fatal consequences from global warming. We also know that a prerequisite for our success is largely dependent on global cooperation. In addition to being a huge country, in terms of population, India also stands out with its clear commitment to renewable energy and green hydrogen. This makes India a very attractive market for countries, such as Norway, with significant access to technology, expertise and financial instruments. By joining forces with India, we strengthen our chances to succeed with common goals within the global energy transformation.

The threat of climate change has finally set in motion a global green transition, moving from fossil energy to renewables at a scale and pace not previously seen. However, the scale and speed required is often under-appreciated. A renewable-energy economy must expand at the same pace as the fossil-fuel economy contracts to keep jobs and energy prices stable. Critically, the transition pace is slowed by economic and social barriers, not technology. Most of the technology required to achieve ambitions climate goals already exists, but to drive a fair, effective and fast transition governments, business, and R&D need to act with unity.

Let us succeed, together!



Ingebjørg Telnes Wilhelmsen

Secretary General at the Norwegian Hydrogen Forum (NHF)

NHF was founded in 1996 as a non-profit member organization, which promotes the advantages of hydrogen and ammonia as energy carriers. NHF members span Norwegian producers, distributors, industry, universities, research institutes, companies in the transportation sector, consulting firms and other organizations interested in hydrogen.



Sturle Pedersen

Greenstat Norway

Experienced Chief Executive Officer with more than 30 years of global experience in leading successful businesses initiatives and ventures through conceptualizing ideas and seizing opportunities.

Extensive experience of initiating and leading international alliances, negotiations, mergers and acquisitions, as well as securing funding and facilitate and build strategic partnership with global industry leaders.

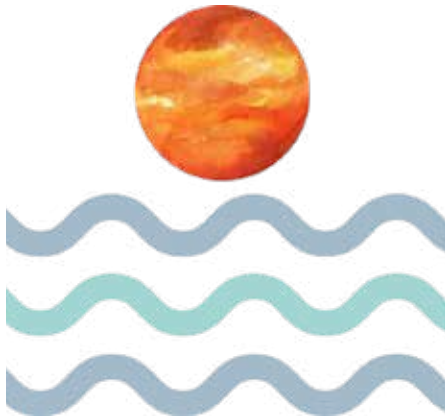
India is one of the world's fastest growing economies, and with impressive plans for rapid growth in renewable energy. This includes investments in 450 GW production capacity of hydrogen by 2030. India's success will undoubtedly mean a lot to every man and woman living in India, and it will also have enormous global environmental impact. It is with great admiration I registered the determination and enthusiasm of India's authorities to facilitate this rapid development and major investments in hydrogen.

Norway is in comparison a "slightly" smaller nation. However, we have unique position within natural gas and infrastructure for CO2 capture and storage. This represent great opportunities for production and export of blue hydrogen. We also have large renewable resources in hydropower and are seeking further development in offshore wind. Norway also have a strong technological competence, a versatile supplier industry and world class research institutes. Thus, Norway is very well positioned to take a significant role in developing the hydrogen economy.

However, the Norwegian export revenues have decreased dramatically in recent years. The Norwegian government has therefore set an ambitious goal of increasing Norway's exports excluding oil and gas by 50 per cent by 2030. This is a huge challenge, but in every challenge there is also possibilities.

I believe there are great opportunities for Indian and Norwegian companies to join their forces and expertise. And I am confident that we together will be able to contribute to a faster reduction of the climate gas emissions.

On behalf of all our members in the Norwegian Hydrogen Forum, it is a great honor to welcome you to this years International Climate Summit 2022. I look forward to seeing you all!



Mr. Pradeep Multani

President, PHD Chamber of Commerce and Industry

An eminent industrialist and a renowned name in the field of Traditional Medicine, Mr. Pradeep Multani, Chairman, Multani Pharmaceuticals Limited having an enriched experience of more than 40 years in the manufacturing of Ayurvedic and Unani medicine and products. He is holding the position of Chairman for last 32 years of a 83 year old prestigious multi crore limited company.

He is also the President of PHD Chamber of Commerce and Industry, Co-Chairman, FICCI - AYUSH Committee and President of Association of Manufacturers of Ayurvedic Medicines (AMAM).

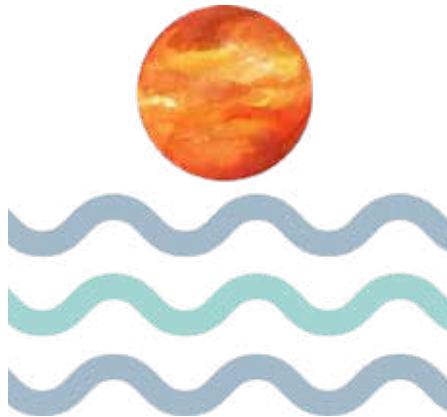
MESSAGE FROM PRESIDENT, PHDCCI

I am happy to announce that PHD Chamber of Commerce and Industry is organising the 'International Climate Summit 2022– Opportunities for Green Hydrogen in India' in Bergen, Norway on 30th and 31st August 2022. This Summit is second of its series after resounding success of International Climate Summit - 2021: Powering India's Hydrogen Ecosystem held on 3rd September, 2021 in New Delhi.

The focus of ICS-2022 at Bergen, Norway is to provide opportunities to global players for making investment in India as it is progressively becoming a favored destination for investment in renewables. Liberal foreign investment policy allows the foreign investors to enter into Joint Ventures with an Indian partner for financial and technical collaboration and for setting up renewable energy-based power generation projects. Up to 100 per cent foreign investment as equity qualifies for automatic approval, under the extant FDI policy of the Government. This event will also provide networking opportunity with several companies for setting up manufacturing bases for electrolyzers, R&D, support with reputed Norwegian labs equipment, supplies, instrumentation and control systems, not only by Norwegian companies but also from other companies participating in the event globally.

Under the vision of our Hon'ble Prime Minister, Shri Narendra Modi ji, sustainable growth is possible only with sustainable energy resources. India can become a global hub of green hydrogen as an ample availability of renewable energy gives the country an inherent advantage.

I convey my best wishes for the grand success of the 2nd International Climate Summit 2022.



Mr. Alok B. Shriram

Former President, PHD Chamber of Commerce and Industry

He is the Senior Managing Director & CEO of DCM Shriram Industries Limited (DSIL), a multi-product company with interest in sugar, alcohol (ethanol), co-generation of power, bottling of potable alcohol, sanitizer, fine chemicals and industrial fibres. He has over 40 years of experience in various Senior Management positions.

MESSAGE FROM FORMER PRESIDENT, PHDCCI & LEADER OF ICS 2022 DELEGATION

It gives me immense pleasure to announce that PHD Chamber of Commerce and Industry is organising the 'International Climate Summit 2022- Opportunities for Green Hydrogen in India' in Bergen, Norway on 30th and 31st August 2022 with Greenstat, Norway and Invest India . The summit is being organised in reciprocity for the event ICS- 2021- "Powering India's Hydrogen Ecosystem" held on 3rd September, 2021 organised by PHDCCI partnered with Invest India and Norway as the Country Partner. Since then, India has moved forward with a fast pace to bring renewable energy, green hydrogen, to the attention of global players, worldwide.

ICS 2022 in Bergen will facilitate global collaboration in building sustainable pathways for production, storage, transportation, distribution, and ambitious deployment of hydrogen technologies.

The government has already taken the first step towards building a hydrogen economy through the National Hydrogen Mission. The most pressing need for us all is to sustain the momentum through coordinated action going into the future.

We hope through ICS 2022 we are able to take forward our PM's Vision and make India a global Green Hydrogen hub.

Let us make the International Climate Summit 2022 in Bergen, Norway a grand success.

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

MESSAGES





Shri Bhupender Yadav

Hon'ble Minister of Labour
and Employment, Environment,
Forest and Climate Change,
Government of India

MESSAGE FROM HON'BLE MINISTER OF LABOUR AND EMPLOYMENT, ENVIRONMENT, FOREST AND CLIMATE CHANGE, GOVERNMENT OF INDIA



It is a matter of great pleasure for me to know that PHD Chamber of Commerce and Industry and Greenstat Hydrogen India Ltd. (Norwegian Enterprise) in partnership with Invest India are organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" at Bergen, Norway on 30th and 31st August, 2022.

Organization of this Summit is very timely. This is the time when we are in urgent need to develop carbon free sources of energy to combat climate change. India has the locational advantage to harness solar energy and to open new avenues for low – cost production of green hydrogen energy. Much R&D is underway in this field. Assembly of top researchers, academicians, industrial experts and policy makers to deliberate will quicken the process of fine-tuning of cost reduction in the entire hydrogen supply chain including its production, storage, transportation, distribution and application.

Hon'ble Prime Minister of India launched the National Hydrogen Mission on India's 75th Independence Day i.e. on 15th August 2021. The Mission aims to aid this government in meeting its climate targets and making India a green hydrogen hub. This will help in meeting the target of production of 5 million tonnes of Green hydrogen by 2030 and the related development of renewable energy capacity.

India presented five nectar elements "Panchamrit" for climate action at Glasgow COP26, including net zero by 2070. The idea of LIFE...i.e., "Lifestyle for Environment" highlighted by Hon'ble Prime Minister of India and the call for global mass movement on sustainable lifestyles is very critical for combating climate Change.

I am sure the summit will be successful in enabling substantive deliberations on 'Green Hydrogen' which is expected to accelerate clean energy transition globally.

With best wishes,

MESSAGE FROM HON'BLE MINISTER OF ROAD TRANSPORT & HIGHWAYS, GOVERNMENT OF INDIA



Shri Nitin Gadkari

Hon'ble Minister of
Road Transport & Highways,
Government of India

It is a great pleasure to know that PHD Chamber of Commerce and Industry is organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" at Bergen, Norway on 30th and 31st August, 2022.

Climate change is a global crisis that goes beyond national borders. It is a concern that requires timely and coordinated efforts. The International Climate Summit 2022 is a step in this direction to raise awareness on using cleaner and greener fuels as an energy alternative and focuses on opportunities for global stakeholder to invest in India and bring technology under the Make-in-India programme of self-reliant India in renewable energy.

Our government at Centre has launched the National Hydrogen Mission on India's 75th Independence Day i.e. on 15th August 2021. The Mission aims to aid this government in meeting its climate targets and making India a green hydrogen hub. This will help in meeting the target of production of 5 million tonnes of Green hydrogen by 2030 and the related development of renewable energy capacity.

I hope ICS 2022 in Bergen, Norway will facilitate global collaboration in Building sustainable pathways for production, storage, transportation, distribution, and ambitious deployment of hydrogen technologies, I am confident that this summit will be able to take forward the vision of our Hon'ble Prime Minister and make India a world leader in hydrogen production.

On this occasion, I extend my heartiest congratulations to PHD Chamber of Commerce and Industry for the successful deliberations at the International Climate Summit in Bergen, Norway.

MESSAGE FROM HON'BLE GOVERNOR OF SIKKIM



Shri Ganga Prasad

Hon'ble Governor of Sikkim

संदेश

अत्यंत हर्ष का विषय है कि पीएचडी चैम्बर ऑफ कॉमर्स एंड इंडस्ट्री और ग्रीनस्टैट हाइड्रोजन इंडिया लिमिटेड (नॉर्वेजियन एंटरप्राइज) तथा इन्वेस्ट इंडिया के साझेदारी में "अंतर्राष्ट्रीय जलवायु शिखर सम्मेलन 2022 - " भारत में ग्रीन हाइड्रोजन के अवसर " का आयोजन 30 और 31 अगस्त 2022, को बर्गन, नॉर्वे में संपन्न हो रहा है ।

इससे भी अधिक हर्ष का विषय है कि भारत के यशस्वी प्रधानमंत्री एवं नॉर्वे के माननीय प्रधानमंत्री को इस सम्मेलन में आमंत्रित किया गया है ।

मुझे पूर्ण विश्वास है कि यह सम्मेलन भारत में अक्षय ऊर्जा और हरित हाइड्रोजन के लिए सुनहरे अवसर प्रदान करेगा। इसके साथ - साथ निवेश एवं उत्पादन के लिए मेगा फैक्टरियाँ स्थापित करने का बढ़ावा मिलेगा ।

मैं ईश्वर से प्रार्थना करता हूँ कि यह सम्मेलन नवाचार, अनुसंधान एवं विकास को बढ़ावा दे और भविष्य में अपने लक्ष्यों को प्राप्त करने और भारत को हाइड्रोजन उत्पादन में विश्व में अग्रणी बनाने के यशस्वी प्रधानमंत्री जी के सपने को आगे बढ़ा सके।

आप सभी को इस कार्यक्रम की सफलता हेतु अग्रिम बधाई एवं शुभकामनाएं।



**Dr. Tamilisai
Soundararajan**

Hon'ble Governor
of Telangana

MESSAGE FROM HON'BLE GOVERNOR OF TELANGANA



I am glad to know that PHD Chamber of Commerce and Industry and Greenstat Hydrogen India Ltd. (Norwegian Enterprise) in partnership with Invest India are organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" In Bergen, Norway on August 30th and 31st , 2022.

I am delighted to learn that the Hon'ble Prime Minister of Norway and the Hon'ble Prime Minister of India are being invited to Inaugurate the event. European countries, the USA, Japan, and several other countries will participate in this event to explore "Opportunities for Green Hydrogen in India."

I am pleased to know that the Energy and Resource Institute (TERI), the World Research Institute (WRI), and several other are knowledge partners for the Summit, and the Summit manifests Norway's extended partnership to India to become Aatma Nirbhar (Self – Reliant) in Renewable Energy and Green Hydrogen.

This two-day summit, I am confident, will explore ideas and provide a global forum for discussion on new advances and innovations in the field of climate change and mitigation.

I extend my warm greetings and best wishes to the organizers and participants. I wish the International Climate Summit – 2022 all success.



Admiral D K Joshi

PVSM, AVSM , YSM , NM , VSM
(Retd.)
Lt. Governor, A&N Islands
&
Vice Chairman, Islands
Development Agency

MESSAGE FROM HON'BLE LIEUTENANT GOVERNOR OF ANDAMAN AND NICOBAR ISLANDS AND VICE CHAIRMAN OF ISLANDS DEVELOPMENT AGENCY



I am pleased to know that PHD Chamber of Commerce and Industry and Greenstat Hydrogen India Ltd. in partnership with Invest India are organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" at Bergen, Norway on 30th and 31st August, 2022.

The vast amounts of water and abundant sunlight have opened the path to Green Energy that could fulfill India's vast demand for fuel. On India's 75th Independence Day, Hon'ble Prime Minister launched the National Hydrogen Mission. Green Hydrogen is seen as one of the enablers for us to meet our climate targets and we are looking forward to producing 5 million tonnes of Green Hydrogen by 2030 and bringing forth the related development of renewable energy capacity.

I am certain that the Summit will deliberate comprehensively on key issues and come out with doable solutions that could transform India to become Aatmanirbhar (Self-Reliant) in Renewable Energy and Green Hydrogen

My best wishes for grand success of this important initiative.



**Shri Thaawarchand
Gehlot**

Hon'ble Governor
of Karnataka

MESSAGE FROM HON'BLE GOVERNOR OF KARNATAKA



I am glad to know that PHD Chamber of Commerce and Industry and Greenstat Hydrogen India Ltd. (Norwegian Enterprise) in partnership with Invest India are organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" at Bergen, Norway on 30th and 31st August, 2022.

The event will offer opportunities in energy transition in India for Renewable Energy and Green Hydrogen, for bringing investment as well as setting up mega factories for green hydrogen production.

I take this opportunity to send my Best Wishes and Warm greetings to the organizers and participants and wish the event a grand success

MESSAGE FROM HON'BLE GOVERNOR OF MADHYA PRADESH



Shri Mangubhai Patel

Governor of Madhya Pradesh

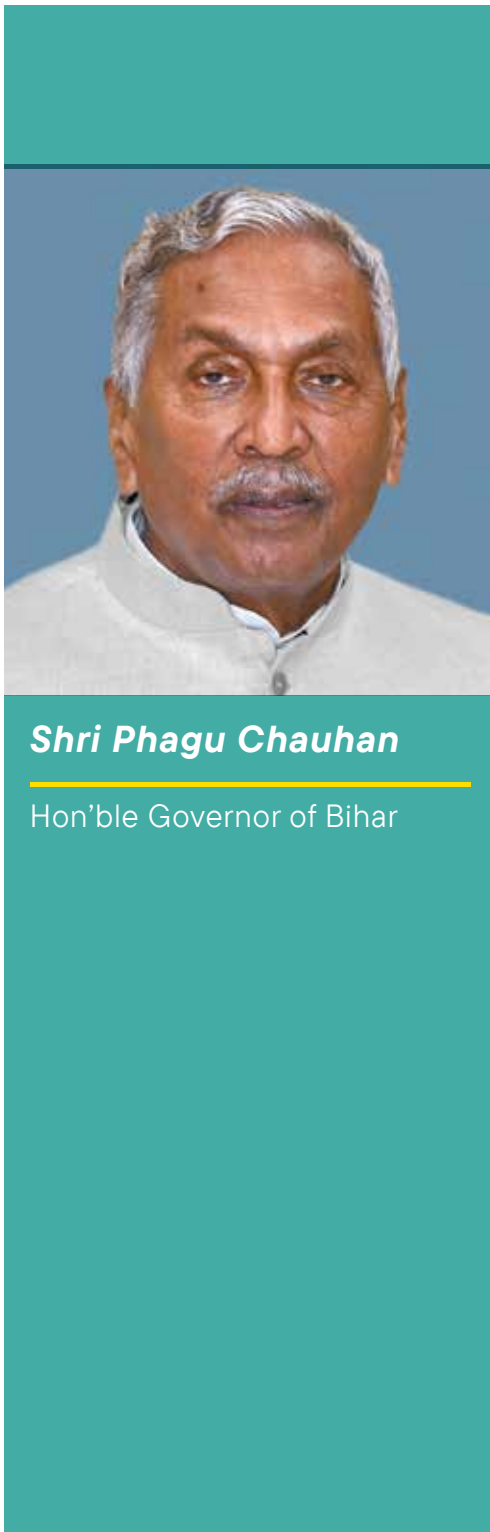
संदेश

हर्ष का विषय है कि पीएचडी चैंबर ऑफ कॉमर्स एंड इंडस्ट्री एवं नॉर्वे के उद्यम ग्रीनस्टैट हाइड्रोजन इंडिया लिमिटेड द्वारा इन्वेस्ट इंडिया के साथ साझेदारी में अंतर्राष्ट्रीय जलवायु शिखर सम्मेलन 2022- भारत में ग्रीन हाइड्रोजन के अवसर का आयोजन 30 और 31 अगस्त 2022 को बर्गन, नॉर्वे में किया जा रहा है।

वर्तमान अर्थव्यवस्था में वैश्विक ऊर्जा खपत और कार्बन उत्सर्जन लगातार जारी है। वातावरण में सीओटू की मात्रा बढ़ रही है जो कि इस धरती को काफी नुकसान पहुंचाएगी। वैकल्पिक और नवीकरणीय ऊर्जा के क्रमिक गमन से ग्लोबल वार्मिंग को रोकने और जीवाश्म ईंधन के उपयोग में कमी के लिए सबसे अधिक संभावना वाला समाधान हरित हाइड्रोजन माना जा सकता है। हरित हाइड्रोजन भविष्य की ऊर्जा है। वास्तव में भावी पीढ़ी के सुरक्षित भविष्य का निवेश हरित ऊर्जा में निवेश है।

आशा है, शिखर सम्मेलन भारत में ग्रीन हाइड्रोजन उत्पादन के अवसरों को प्रमुखता से प्रस्तुत करेगा। निवेशकों को अक्षय और हरित ऊर्जा उत्पादन प्रक्रियाओं में विनियोग के आकर्षक विकल्प उपलब्ध कराने में सफल होगा।

शुभकामनाएँ,



Shri Phagu Chauhan

Hon'ble Governor of Bihar

MESSAGE FROM HON'BLE GOVERNOR OF BIHAR



It is a matter of great pleasure that the PHD Chamber of Commerce and Industry and Greenstat Hydrogen India Ltd. (Norwegian Enterprise) in partnership with Invest India are organizing the International Climate Summit, 2022 "Opportunities for Green Hydrogen in India" at Bergen, Norway on 30th & 31 August 2022.

I hope, this summit will provide an opportunity to all the participants to interact with each other and discuss different aspects of this relevant topic.

I extend my warm greetings and felicitation to the organizers and the participants and wish the summit all success.



Shri Manohar Lal Khattar

Hon'ble Chief minister of
Haryana, Chandigarh

MESSAGE FROM HON'BLE CHIEF MINISTER OF HARYANA, CHANDIGARH



It gives me immense pleasure to know that PHD Chamber of Commerce & Industry and Greenstat Hydrogen India Ltd. (Norwegian Enterprise) in partnership with Invest India are organizing the 'International Climate Summit 2022' - "Opportunities for Green Hydrogen In India" at Bergen, Norway on 30th and 31st August, 2022.

I appreciate the decision to hold an international summit on a topic of prime importance as it will provide an apt platform to the participants to not only explore the opportunities available in India for Green Hydrogen, but also to discuss threadbare on the importance of green hydrogen and its use as a promising source of energy.

To fulfill the commitment of substantially reduce its carbon footprint in the future, the Government of India has already announced its National Hydrogen Energy Mission to outline hydrogen centric policies and regulations to build India's capacity to become the cheapest hydrogen producer in the world. As far as Haryana is concerned the State Government has implemented a number of incentive based schemes to promote non-conventional sources of energy and to make the people conscious of the need for conservation of environment and other natural resources.

I extend my best wishes for the success of the summit.

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

Green Transformation: A Win-Win Opportunity for India



Green Transformation: A Win-Win Opportunity for India



Image Credit: PMO

Few focused on the fact that North American historical climate emissions are more than 25 times than Indian. Even today the US emits eight times more than India per capita every year. India has no reason to accept blame. But India has all the reasons to adopt a new win - win formula for a greener future. Climate action is not a problem to India and even less a cost. It's an enormous opportunity for Indian triple wins. Creating prosperity, making Indian lives better, protecting Mother Earth.

For many decades the debate in India was simple: Do we want to develop or do we want to care for the environment?

Economists argued that rapid development would always come with costs to mother earth while environmentalists countered that we should put the planet first. The economist always won this

debate. Not surprisingly for nearly all Indians rapid development, bringing Indians out of poverty, was the number one priority.

This discussion now smells so much of the 20th century. From the industrial revolution until recently no nation could develop fast and protect the environment at the same time. Industrialization came with an assault on nature. Economic growth was based on fossil fuels, coal in particular. The pattern was the same everywhere – rapid economic growth with a lot of harm both to the workforce and to the environment. When a country had become rich it started caring for the environment. This was true first in the UK, then in Germany and the rest of Europe, in North America, in Japan and Korea and most lately in China.

The good news in the 21st century is that for the first time in human history a new development paradigm is possible. The win – lose debate where you had to choose between development and environment is replaced by the win – win opportunity where rapid parallel progress on both economy and ecology can establish an ecological civilization. Climate change and the environment crisis become an opportunity for jobs and prosperity.

At the core of this change is the drop in price of renewables. When the world came together for the famous disaster of climate talks in Copenhagen in 2009 all focus was on climate diplomacy. No one talked about the climate economy. I cannot remember anyone even hinting to a future with a 90% fall in the price of solar energy.

Thanks mainly to China but also to India solar energy is now cheaper than coal everywhere. Solar energy in India is indeed the cheapest energy which has ever existed on the planet. Going solar brings more jobs and saves money.

No one has understood this better than Prime Minister Modi. He has cast around the Indian debate from win-lose to win win. When my good friend Jairam Ramesh came back from climate talks during the time of Congress rule he was normally always accused of “selling out”. If he had agreed to common positions during the talks, domestic critics claimed that he had not fought hard enough for Indian development. Now fortunately, it’s all about the win – wins.

India is a global leader in solar energy. With president Macron of France prime minister Modi formed the International Solar Alliance to support the global solar economy. India is home to the first all solar airport in the world in Kochi, Kerala and the first all solar rail station in Assam. Some of the largest concentrated solar plants on the planet are hosted in states like Rajasthan, Karnataka and Madhya Pradesh. Roof top solar provides energy for homes and village businesses in Uttar Pradesh and many other states.

When Prime Minister Modi recently launched a green hydrogen mission for India the response

was univocal and promising. Two of the tycoons of Indian business, Ambani from Mumbai and Adani from Ahmedabad put enormous amounts of rupees on the table for green hydrogen. Many smaller enterprises reacted in unison.

The war in Ukraine will supercharge this move towards energy independence. India does not share the European focus on independence from Russia. But nearly all oil and gas consumed in India is imported. Volatile and high prices create a huge burden for the Indian economy. The sun, the wind and the waterfalls are all Indian, all domestic. Every megawatt of energy produced by solar rather than imported oil creates jobs in India and saves money for better use for the people of India.

Agriculture is next to renewables in importance for the green transition of India. Andhra Pradesh shows the way, with Sikkim, Madhya Pradesh and others following. The Zero Budget Natural Farming program in Andhra is the world leading charge towards green agriculture. One million farmers, six million people, have made the move from traditional chemical heavy agriculture into a future where pesticides and fertilizer are reduced or avoided. They are replaced by a scientific mix of cow dung and cow urine, with use of residues from previous harvests as fertilizer. Insect repellent plants replace pesticides. The result is better yields and income for farmers, improved health and better care for soil. The Andhra program is called a pilot. But it is already encompassing more people than the inhabitants of my nation Norway. Soon all farmers in Andhra may join. Prime Minister Modi has highlighted this great initiative as a model for India.

This summer Sadhguru, the most inspiring spiritual leader from Coimbatore, embarked upon an epic motorbike ride from London to Delhi to bring attention to the need to save soil. If we destroy soil, we destroy life, he says Andhra Pradesh shows how we can act better and smarter.

Treeplanting and greening of landscapes add to the benefits of better farming. Telangana is an Indian and global frontrunner in treeplanting. The state has increased its tree cover by three percent over a few years. Hyderabad has been awarded title as a Tree City of the World. I was very impressed visiting its beautiful urban forests and parks. The greening of such a megacity is a great example of win - win policies. Hyderabad becomes more attractive for its citizens and for tourists while at the same time contributing to climate mitigation and pollution control.

Electric mobility adds to renewables, eco agriculture and tree planting as a fourth pillar in a green and climate friendly India. Aaditya Thackeray, the very ambitious environment minister of Maharashtra is launching green developments by the day. I had the privilege last year to join him launching electric buses for Mumbai. In a few years all buses in Mumbai will run on electric power - a wide variety of vehicles from minibuses to two storey buses. The state of Maharashtra

has also developed a policy for the shift into electric personal vehicles, two, three and four wheelers. The state will help establish a network of charging stations to facilitate the transformation. Experience from Norway shows exactly this. Initially you need government regulations to drive the change. When a critical mass of electric vehicles is reached the market takes over.

Buses for Mumbai are produced by Tata in Pune. So it's a win - win. Good for jobs and the economy, good for our fight against the triple environment crisis of climate change, pollution and nature destruction.


When India now acts decisively to combat the climate crisis it's of course not only because it provides a great economic and ecological opportunities. It is also because India is more vulnerable than most to climate change.

This summer has seen unprecedented heat waves in already warm northern India. The last years have recorded serious floods and cyclones. Most seriously of all is a worrying pattern of melting of the glaciers in the Himalayas. If under the worst of circumstances the Himalayan glaciers were to disappear, many of the great Asian rivers will be seasonal rivers with horrifying consequences for hundred of millions of people along Ganga and other waterways.

But while the climate prospects are troubling, there are also reasons for optimism. Natural catastrophies will be more frequent, but they will be much less deadly than in the past. India has a strong state and vibrant civil society which will help people handle crises. We saw this on display in 2019 during cyclone Fani in Odisha. It was one of the worst cyclones hitting India in modern time, but killed very few people. India weather forecasting was precise and gave exact warning on the landfall of the cyclone. The responsible chief minister of Odisha mobilized transport to get a million people out of the danger zone. No one died after the cyclone from the twin warriors of the past - hunger and disease.

Adding to the domestic benefits, climate action will also help India in global geopolitics. China last year produced 80% of all solar panels, 70% of all electric batteries and 80% of all new hydro-power. Around 70% of all green high speed trains are running on Chinese tracks and 99% of all electric buses running on Chinese roads. China is on course to become the green superpower of the 21st century. But India can cooperate with China and compete with China. India will soon be the world's second biggest solar power. The young population and the current higher economic growth give India "longterm" advantages.

At the first global environment conference in Stockholm in 1972, Indira Gandhi gave a passionate speech recalling how she in her youth felt the kinship with nature, with birds, plants and



stones. She famously hammered in that poverty is the greatest polluter. Now, 50 years later, we must make the same link between development and environment as Indira Gandhi, but with an optimistic tweak. We have all the policies, technologies and finances needed to develop fast while caring for the planet. The future is win - win.

{Erik Solheim is a Norwegian diplomat and former politician. He served in the Norwegian government from 2005 to 2012 as Minister of International Development and Minister of the Environment, and as Under-Secretary-General of the United Nations and Executive Director of the United Nations Environment Programme (UNEP) from 2016 to 2018}

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA



INDUSTRY
ARTICLES





AUTHOR

Dr. Jeewan Prakash Gupta

Summit Chair and
Chair Environment Committee, PHDCCI

Circular Economy

India aspires to be five trillion-dollar economy by 2025 that would generate business and new entrepreneurs. This would also increase resource and energy consumption and waste generation. To achieve the target of five trillion-dollar economy in tune with sustainable development principles, it is necessary to ensure low carbon footprints for climate-change. Principles of circular economy is going to be the key driver to achieve this mission.

Circular systems emphasize on reuse, repair, refurbish, remanufacture and recycle, thereby minimizing wastes that reach landfills or incinerators, reducing carbon emissions and utilizing clean energy. In contrast to the linear systems that have been working on the concept to create, use and dispose, the circular system is a close-loop system where the use of created products is extended, useful parts of the old equipment are suitably used in refurbishment of same or other type of equipment or for creating a new one. Such materials reduce the need of raw materials, resources, energy (retain embedded energy) and the polluting processes. The wastes of a process or a by-product is used as raw material for the other process or there is resource recovery for manufacturing of a new product. This prevents the wastes from going to landfill sites or incinerators. Only the residual material not worth using again and again goes to landfill/incinerator. The non-toxic biological materials are returned to soil.

Circular economy can be implemented in all sectors. The “regenerative” approach of circular economy is in contrast to throw away attitude of capitalist society of “make, use and dispose”. The developing world has been observing circular strategy since long due to lack of resources

and has been reusing, recycling and remaking objects with same or different use. This saves on the material and other costs.

With the environment law enforcing agencies enacting stringent environment laws, many vehicles not conforming to these will go off the roads. This provides immense opportunities for circular strategies to remake vehicles with the old parts of abandoned vehicles.

Plastic industry is another important one for circular economy. Globally, 8.3 billion tons of plastic was produced between 1950-2015. Out of 6.3 billion tons which became waste, 4.9 billion tons reached the dumpsites. With the increasing trend of plastic manufacturing, an estimated 12 billion tons of plastic will be dumped in environment by 2050. Circular strategy in the close-loop system encourages its reuse, recycle, remanufacturing and finally safe disposal. Waste plastic can be used for thermal insulation of houses. In India, major industries dealing with plastic have come together last year, to form an alliance against plastic waste. India recycles or reuses over 90 per cent of all the PET (polyethylene terephthalate plastic) manufactured in the country.

India has also shown improved electronics recycling. By signing 'extended producer responsibility' more than 700 electronics producers have come together to reduce e- waste.

There is a huge scope of reusing, repairing, refurbishing, remaking and recycling in the textile industry. Craze for new variety and style has pushed new generation into buying surplus clothes. The owner's utilization time and recycling of the clothes is very low due to which natural resources of more than \$ 500 billion are lost every year, according to the experts.

Economic analysis shows that three important areas, viz. cities and construction, food and agriculture, and mobility and vehicle manufacturing could bring annual benefits of Rs 40 lakh crores worth circular economy by 2050.

India's material consumption is expected to rise from 7.5 billion tons in 2015 to 15 billion tons in 2030. India's rate of resource extraction including mining of virgin resources is nearly three times higher than global average. In light of this resource efficiency and waste management can bring down, consumption and waste to almost nil. This will result in huge reduction in millions of tonnes of waste and CO2 emissions.

The government policy arises to enable reuse of waste and redouble recycle rate of key materials to 50% in five years. It envisions setting up a National Resource Efficiency Authority which like the Bureau of Energy Efficiency strategies for key sectors – automobiles, plastic packaging,

building and construction sector, electrical and electronic sector equipment sector, solar photo-voltaic sector, and steel & aluminum to begin with.

To implement circular economy principles and circular economy strategies in organizations, the British Standards Institution (BSI) had launched the standard "BS 8001:2017". India is realizing the importance of having its own regulatory framework such as National Material Recycling Policy, National Policy on Resource Efficiency, Bureau of Resource Efficiency (BRE) etc. There is a need to integrate resource circularity in the Industrial Revolution (IR) 4.0 strategies.

In India, it is estimated that circular economy may provide opportunities worth \$218 billion per year by 2030. According to NITI Aayog CEO Amitabh Kant, fast increasing human population will raise the total global mineral and material demand from 50 billion tonnes in 2014 to 130 billion tonnes in 2050. For sustainable development, resource efficiency and circularity is imperative.

Produce, consume and discard needs rejuvenation. Resource efficiency and waste management will need to be the key drivers of a green strategy, because it is now the only viable path, capable of creating growth, new enterprises, and a clean environment.

2020 is an essential milestone towards agenda 2030, a global commitment to achieve sustainable development by 2030.

Technologies for Hydrogen Production¹ - Dr. J P Gupta

Processes:

- Thermal processes: Use the energy in various feed stocks i.e. natural gas, coal and biomass to release the H₂ that is the part of their molecular structure. Thermo-chemical processes use heat in combination with a closed chemical cycle to produce H₂ from water. Steam reforming of natural gas is the main thermal process for hydrogen production. The process involves reaction of natural gas and steam over nickel based catalyst. The process breaks methane component of the natural gas into carbon monoxide (CO) and H₂ gas.
- Electrolytic processes: These processes use electricity to split water into chemical constituents Hydrogen and Oxygen (O₂) using electrolyzer.
- Photolytic Processes: These processes use light energy to split water into H₂ and O₂.

The Table below shows the operating characteristics of the four types of electrolyses:

	Alkaline	PEM	AEM	Solid Oxide
Operating Temperature	70-90 C	50-80 C	40-60 C	700-850 C
Operating Pressure	1-30 Bar	< 70 Bar	< 35 Bar	1 Bar
Electrolyte	Potassium hydroxide (KOH) 5-7 molL ⁻¹	PFSA membranes	DVB polymer support with KOH or NaHCO ₃ 1 molL ⁻¹	Yttria-stabilized Zirconia (YSZ)
Separator	ZrO ₂ stabilized with PPS mesh	Solid electrolyte (above)	Solid electrolyte (above)	Solid electrolyte (above)
Electrode/ Catalyst (oxygen side)	Nickel coated perforated stainless steel	Iridium oxide	High surface area Nickel or NiFeCo alloys	Perovskite-type (e.g. LSCF, LSM)
Electrode/ catalyst (hydrogen side)	Nickel coated perforated stainless steel	Platinum nanoparticles on carbon black	High surface area nickel	Ni/YSZ
Porous transport layer anode	Nickel mesh (not always present)	Platinum coated sintered porous titanium	Nickel foam	Coarse Nickel-mesh or foam
Porous transport layer cathode	Nickel mesh	Sintered porous titanium or carbon cloth	Nickel foam or carbon Cloth	None
Bipolar plate anode	Nickel-coated stainless steel	Platinum-coated titanium	Nickel-coated stainless steel	None
Bipolar cathode	Nickel-coated stainless steel	Gold-coated titanium	Nickel-coated Stainless steel	Cobalt-coated stainless steel
Frames and sealing	PSU, PTFE, EPDM	PTFE, PSU, ETFE	PTFE, Silicon	Ceramic Glass

Broad Cost Comparison of Various Processes:

Process	Energy Required (kWh/Nm ³)		Status of Tech.	Efficiency (%)	Costs Relative to SMR
	Ideal	Practical			
Steam methane reforming (SMR)	0.78	2-2.5	mature	70-80	1
Coal gasification (GE Energy(/research/coal/energy-systems/gasification/gasifipedia/ge))	1.01	8.6	mature	60	1.4-2.6
Partial oxidation of coal			mature	55	
H ₂ S methane reforming	1.5		R&D	50	<1
Landfil gas dry reformation			R&D	47-58	~1
Partial oxidation of heavy oil	0.94	4.9	mature	70	1.8
Naphtha reforming			mature		
Steam reforming of waste oil			R&D	75	<1
Steam-iron process			R&D	46	1.9
Chloralkali electrolysis			mature		by product
Grid electrolysis of water	3.54	4.9	R&D	27	03-Oct
Solar & PV-electrolysis of water			R&D to mature	10	>3
High-temp. electrolysis of water			R&D	48	2.2
Thermochemical water splitting			early R&D	35-45	6
Biomass gasification			R&D	45-50	2.0-2.4
Photobiological			early R&D	<1	
Photolysis of water			early R&D	<10	
Photoelectrochemical decomp. Of water			early R&D		
Photocatalytic decomp. Of water			early R&D		

Energy Contents of different fuels.

Fuel	Energy content (MJ/kg)
Hydrogen	120
Liquefied natural gas	54.4
Propane	49.6
Aviation gasoline	46.8
Automotive gasoline	46.4
Automotive diesel	45.6
Ethanol	29.6
Methanol	19.7
Coke	27
Wood (dry)	16.2
Begasse	9.6

Hydrogen Production Technologies

- Water Electrolysis

It can be defined in the simplest form by using two electrodes in water and passing the electrical current water is converted into hydrogen and oxygen. The water electrolysis method can be divided into three different types of the electrolyte alkaline, proton exchange membrane (PEM), and solid oxide electrolyzers (SOE). Below Table has been listed the typical specifications of the water electrolysis technologies methods. The commercial low temperature electrolyzers were developed and have efficiencies of (56% – 73%) at conditions of (70.1 – 53.4 kWh.kg⁻¹ H₂ at 1 atm and 25°C) [93]. Alkaline electrolysis systems are the most commonly compared to other water electrolysis methods. Solid oxide electrolysis (SOE) is the most electrically efficient but still are under development. Corrosion, seals, thermal cycling, and chrome migration are the major challenges faced by the SOE technology. The Proton exchange membrane (PEM) electrolysis systems are more efficient than alkaline electrolyser. Also, the corrosion and seals issues don't exist as (SOE), but the cost of (PEM) is too high compared with alkaline electrolyzers systems. Alkaline electrolyser systems have the lowest capital cost and have the lowest efficiency so the electrical energy cost is too high. Recently, electrolyzers are used for producing pure hydrogen and high pressure units have been developed [97].

The advantage of using the high pressure operation unit is to eliminate using expensive hydrogen compressors. The hydrogen production using the water electrolysis systems are showed the too high cost to generate hydrogen on large scale using the water electrolysis method. Additionally, the water electrolysis.

The typical specifications of alkaline, PEM and SOE

Specification	Alkaline	PEM	SOE
Technology maturity	State of the art	Demonstration	R & D
Cell temperature, °C	60 - 80	50 - 80	900 - 1000
Cell pressure, bar	<30	<30	<30
Current density, A/cm ²	0.2 - 0.4	0.6 - 2.0	0.3 - 1.0
Cell voltage, V	1.8 - 2.4	1.8 - 2.2	0.95 - 1.3
Power density, W/cm ²	Up to 1.0	Up to 4.4	-
Voltage efficiency, %	62 - 82	67 - 82	81 - 86
Specific system energy consumption, kWh/Nm ²	4.5 - 7.0	4.5 - 7.5	2.5 - 3.5
Partial load range,%	20 - 40	0 - 10	-
Cell area, m ²	<4	<300	-
Hydrogen production, Nm ² /hr	<760	<30	-
Stack lifetime, hr	<90,000	<20,000	<40,000
System lifetime, yr	20 - 30	10 – 20	-
Hydrogen purity, %	>99.8	99.999	-
Cold start-up time, min	15	<15	>60

systems are utilized the non-renewable power generation source to produce electricity for the water electrolysis systems [98] [99] [100] [101] [102] .

- Alkaline Electrolyser

This type is commonly used on the large-scale systems. Alkali solutions are divided into two different electrolyte types. The first electrolyte type is potassium hydroxide (KOH) with a weight percent of (20% - 40%) [104] . Sodium hydroxide (NaOH) and sodium chloride (NaCl) have been used as the other alkaline electrolyte types. The separating diaphragm between the two electrodes is made of the asbestos material with a thickness of 3 mm and due to the usage of the asbestos materials the water electrolyser operation temperature is limited to be 80°C. Hydrogen and hydroxide are generated at the cathode part, then the hydroxide is moved to the anode part generating oxygen. The anode and cathode part reactions can be expressed.

- Proton Exchange Membrane Electrolyser

To overcome the corrosion has happened from the alkaline electrolyzers method, the solid polymer membrane has been investigated to use in the PEM fuel cells technology. However, the deionized water with high purity has been required for the water electrolysis process. The oxidation reaction of water is happened at the anode part generating oxygen, electrons, and protons. The electrons and protons are moved to the cathode side through the PEM. The hydrogen gas is generated at the cathode part after the protons reduced.

- Solid Oxide Electrolyser

The solid oxide electrolyser (SOE) operation temperature can be reached at 1000°C compared with the PEM electrolyser. These systems typically are used the thermal energy instead of a part of the electrical energy. The electrolyser efficiency is increased by increasing high temperature. Therefore, compared to alkaline and PEM processes the SOE process has a higher efficiency. In the SOE system, hydrogen is generated at the cathode part and the oxide anions are passed to the anode where oxygen will form through the solid electrolyte.

- Biomass

Biomass energy is used to generate hydrogen fuel as a renewable energy source. Biomass energy sources such as agricultural wastes, animal wastes, municipal solid waste, etc. are used. The biomass technologies for hydrogen production can be divided into the gasification, and pyrolysis. The hydrogen production yield of the biomass process is affected with the biomass characteristics and compositions are affected with a number of process variables such as temperature, heating rate, moisture content, particle size, reactor system, etc.

- Biomass Gasification Process

The Gasification process can be commonly used in the biomass and coal gasification processes. It is commercially used in many processes and it has been based upon the partial oxidation process of the materials to get the mixture of hydrogen, carbon monoxide, methane, etc. Since the moisture has to be vaporized, the thermal efficiency of the gasification process is typically low. The recorded performance of the fluidized bed reactors is higher than the fixed bed type reactors. Syngas is produced from steam reforming process when steam or oxygen is added to the gasification process, which it can be utilized for hydrogen production in the water gas shift (WGS) or the Fischer-Tropsch reactor. Biomass is dried by using superheated steam at 900°C. The high hydrogen production yields can be achieved from the dried biomass. Based on the lower heating value, the achieved efficiencies of these reactors within range of (35% - 50%).

- Biological Hydrogen Production Process

This is another biomass method to produce hydrogen gas fuel using the biological technologies. There can be utilized the anaerobic bacteria which it is grown in the dark fermentation bioreactors or can be used algae in the light in the photo fermentative process. The main processes include the photolytic process to produce hydrogen from water using the green algae, the hydrogen production using the dark-fermentative process of anaerobic digestion, the two-stage dark/fermentative process, the photo-fermentative processes and the WGS method for hydrogen production. By using the anaerobic microorganisms the dark fermentation reaction is carried out to convert the carbohydrate to hydrogen and other final products.

Biological Hydrogen Production Process limits the low hydrogen production capacity compared with the unit capital investment. This is the major challenge of the dark fermentation method.

(Note: 1 Journal of Power and Energy Engineering, 107-154, 2019)

Hydrogen Storage*

The hydrogen consumes a large volume even after compressing it at very high pressure. Commercially available fuel cell vehicles opt for 700 bar storage pressure as hydrogen occupies a large space at low pressure. Similarly, high-pressure tanks for decentralized storage of hydrogen especially for transport applications are necessary. However, tanks capable of holding such high pressure are generally made up of carbon fiber which is a very expensive material. As the pressure requirement increases, the quantity of carbon fiber required for the tank rises along with the up-gradation of this compression system specification which can increase the initial cost of storage. Hence many researchers are now focusing on the hydrogen production methods, transportation of hydrogen, and its storage.

Liquefaction of hydrogen requires a significant energy input as the boiling point of hydrogen is very low (-253°C) but liquid hydrogen provides comparatively a high storage density. Liquefaction consumes about 30% of hydrogen energy. The high volumetric density is the main advantage of liquid hydrogen storage.

Another means of hydrogen storage is adsorption which exhibits van der Waals bonding between hydrogen molecules and materials that store hydrogen in the solid phase. Metal hydrides and chemical hydrides exhibit these reactions and operate at low pressure.

All three storage options have their respective limitations and hence currently there is no perfect solution for hydrogen storage. Many researchers are continuously working in this field to provide a better solution for hydrogen storage and with development, it is improving day by day.

The smooth operation of large-scale and intercontinental hydrogen value chains in the future will require a much broader variety of storage options. At an export terminal, for example, hydrogen storage may be required for a short period prior to shipping. Hours of hydrogen storage are needed at vehicle refueling stations, while days to weeks of storage would help users protect against potential mismatches in hydrogen supply and demand. Much longer-term and larger storage options would be required if hydrogen were used to bridge major seasonal changes in electricity supply or heat demand, or to provide system resilience.

The most appropriate storage medium depends on the volume to be stored, the duration of storage, the required speed of discharge, and the geographic availability of different options. In general, however, geological storage is the best option for large-scale and long-term storage, while tanks are more suitable for short-term and small-scale storage.

Storage tanks

Tanks storing compressed or liquefied hydrogen have high discharge rates and efficiencies of around 99%, making them appropriate for smaller-scale applications where a local stock of fuel or feedstock needs to be readily available. Compressed hydrogen (at 700 bar pressure) has only 15% of the energy density of gasoline, so storing the equivalent amount of energy at a vehicle refueling station would require nearly seven times the space.

Ammonia has a greater energy density and so would reduce the need for such large tanks, but these advantages have to be weighed against the energy losses and equipment for conversion and reconversion when end uses require pure hydrogen.

When it comes to vehicles rather than filling stations, compressed hydrogen tanks have a higher energy density than lithium-ion batteries, and so enable a greater range in cars or trucks than is possible with battery electric vehicles. Research is continuing with the aim of finding ways to reduce the size of the tanks, which would be especially useful in densely populated areas. This includes looking at the scope for underground tanks that can tolerate 800 bar pressure and so enable greater compression of hydrogen. Hydrogen storage in solid-state materials such as metal and chemical hydrides is at an early stage of development, but could potentially enable even greater densities of hydrogen to be stored at atmospheric pressure.

Hydrogen Storage Projects Undertaken in India

Indian Oil Corporation Limited (IOCL) is also working on the development of a Type-3 High Pressure Hydrogen Cylinder in collaboration with IIT Kharagpur. The cylinder increases the energy storage density over existing cylinders. They are also working on developing material-based hydrogen storage including metal-organic frameworks (MOFs). Their research is focused on producing high energy density MOFs, which can be scaled up cost-effectively.

There are main problems for hydrogen storage such as:

- reducing weight and volume of thermal components is required;
- the cost of hydrogen storage systems is too high;

- durability of hydrogen storage systems is inadequate;
- hydrogen refueling times are too long;
- high-pressure containment for compressed gas and other high-pressure approaches limits the choice of construction materials and fabrication techniques, within weight, volume, performance, and cost constraints.

For all approaches of hydrogen storage, vessel containment that is resistant to hydrogen permeation and corrosion is required. Research into new materials of construction such as metal ceramic composites, improved resins, and engineered fibers is needed to meet cost targets without compromising performance. Materials to meet performance and cost requirements for hydrogen delivery and off-board storage are also needed.

At the moment, several kinds of technologies of hydrogen storage are available such as;

- The simplest is compressed H₂ gas. It is possible at ambient temperature, and in- and out-flow are simple. However, the density of storage is low compared to other methods.
- Liquid H₂ storage is also possible: from 25% to 45% of the stored energy is required to liquefy the H₂. At this method the density of hydrogen storage is very high, but hydrogen boils at about -253°C and it is necessary to maintain this low temperature (else the hydrogen will boil away), and bulky insulation is needed.
- In metal hydride storage the powdered metals absorb hydrogen under high pressures. During this process heat is produced upon insertion and with pressure release and applied heat, the process is reversed. The main problem of this method is the weight of the absorbing material – a tank's mass would be about 600 kg compared to the 80kg of a comparable compressed H₂ gas tank.
- More popular at this time is carbon absorption: the newest field of hydrogen storage. At applied pressure, hydrogen will bond with porous carbon materials such as nanotubes.

High pressure hydrogen storage

The most common method of hydrogen storage is compression of the gas phase at high pressure (> 200 bars or 2850 psi). Compressed hydrogen in hydrogen tanks at 350 bar (5,000 psi) and 700 bar (10,000 psi) is used in hydrogen vehicles. There are two approaches to increase the gravimetric and volumetric storage capacities of compressed gas tanks. The first approach

involves cryo-compressed tanks. This is based on the fact that, at fixed pressure and volume, gas tank volumetric capacity increases as the tank temperature decreases. Thus, by cooling a tank from room temperature to liquid nitrogen temperature (77K), its volumetric capacity increases. However, total system volumetric capacity is less than one because of the increased volume required for the cooling system. The limitation of this system is the energy needed to compression of the gas. About 20 % of the energy content of hydrogen is lost due to the storage method. The energy lost for hydrogen storage can be reduced by the development of new class of lightweight composite cylinders. Moreover, the main problem consisting with conventional materials for high pressure hydrogen tank is embrittlement of cylinder material, during the numerous charging/discharging cycles.

Liquefaction

The energy density of hydrogen can be improved by storing hydrogen in a liquid state. This technology developed during the early space age, as liquid hydrogen was brought along on the space vessels but nowadays it is used on the on-board fuel cells. It is also possible to combine liquid hydrogen with a metal hydride, like Fe-Ti, and this way minimize hydrogen losses due to boil-off.

In this storage method, first gas phase is compressed at high pressure than liquefy at cryogenic temperature in liquid hydrogen tank (LH2). The condition of low temperature is maintained by using liquid helium cylinder. Hydrogen does not liquefy until -253°C (20 degrees above absolute zero) such much energy must be employed to achieve this temperature. However, issues are remaining with LH2 tanks due to the hydrogen boil-off, the energy required for hydrogen liquefaction, volume, weight, and tank cost is also very high. About 40 % of the energy content of hydrogen can be lost due to the storage methods. Safety is also another issue with the handling of liquid hydrogen as does the car's tank integrity, when storing, pressurizing and cooling the element to such extreme temperatures.

Solid state hydrogen storage

As mentioned above, certainly some practical problems, which cannot be circumvented, like safety concerns (for high pressure containment), and boil-off issues (for liquid storage), both are challenging for hydrogen storage. There is a third potential solution for hydrogen storage such as (i) metal hydrides and (ii) hydrogen adsorption in metal-organic frameworks (MOFs) and carbon-based systems.

In these systems, hydrogen molecules are stored in the mesoporous materials by physisorption (characteristic of weak van der Waals forces). In the case of physisorption, the hydrogen capacity of a material is proportional to its specific surface area. The storage by adsorption is attractive because it has the potential to lower the overall system pressure for an equivalent amount of hydrogen, yielding safer operating conditions. The advantages of these methods are that the volumetric and cryogenic constraints are abandoned. In recent decades, many types of hydrogen storage materials have been developed and investigated, which include hydrogen storage alloys, metal nitrides and imides, ammonia borane, etc.

Currently, porous materials such as zeolites, MOFs, carbon nanotubes (CNTs), and graphene also gained much more interest due to the high gravimetric density of such materials.

Hydrogen storage in metal hydrides

Initially, metal alloys, such as LaNi_5 , TiFe and MgNi were proposed as storage tanks since by chemical hydrogenation they form metal hydrides. Later, hydrogen can be released by dehydrogenation of metal hydrides with light elements (binary hydrides and complex hydrides) because of their large gravimetric H_2 densities at high temperature. Regarding vehicle applications, metal hydrides (MHs) can be distinguished into high or low temperature materials. This depends on the temperature at which hydrogen absorption or desorption is taking place. Normally, in MHs hydrogen uptake and release kinetics is considered as above or below of $150\text{ }^\circ\text{C}$, respectively. La-based and Ti-based alloys are examples of some low temperature materials with their main drawback as they provide very low gravimetric capacity ($<2\text{ wt } \%$).

The analysis of above LiAlH_4 (LAH) shows that the gravimetric weight ratio of hydrogen is $10.6\text{ wt } \%$; thereby LAH seems a potential hydrogen storage medium for future fuel cell powered vehicles. But, in practice the hydrogen storage capacity is reduced to $7.96\text{ wt } \%$ due to the formation of $\text{LiH} + \text{Al}$ species as the final product. Due to this, a substantial research effort has been devoted to accelerating the decomposition kinetics by catalytic doping in the MHs. The high hydrogen content, as well as the discovery of reversible hydrogen storage is reported in Ti-doped NaAlH_4 . In order to take advantage of the total hydrogen capacity, the intermediate compound LiH must be dehydrogenated as well. Due to its high thermodynamic stability this requires temperatures higher than $400\text{ }^\circ\text{C}$ which is not considered feasible for transportation purposes. Another problem related to hydrogen storage is the recycling back to LiAlH_4 due to its relatively low stability, requires an extremely high hydrogen pressure in excess of 10000 bar .

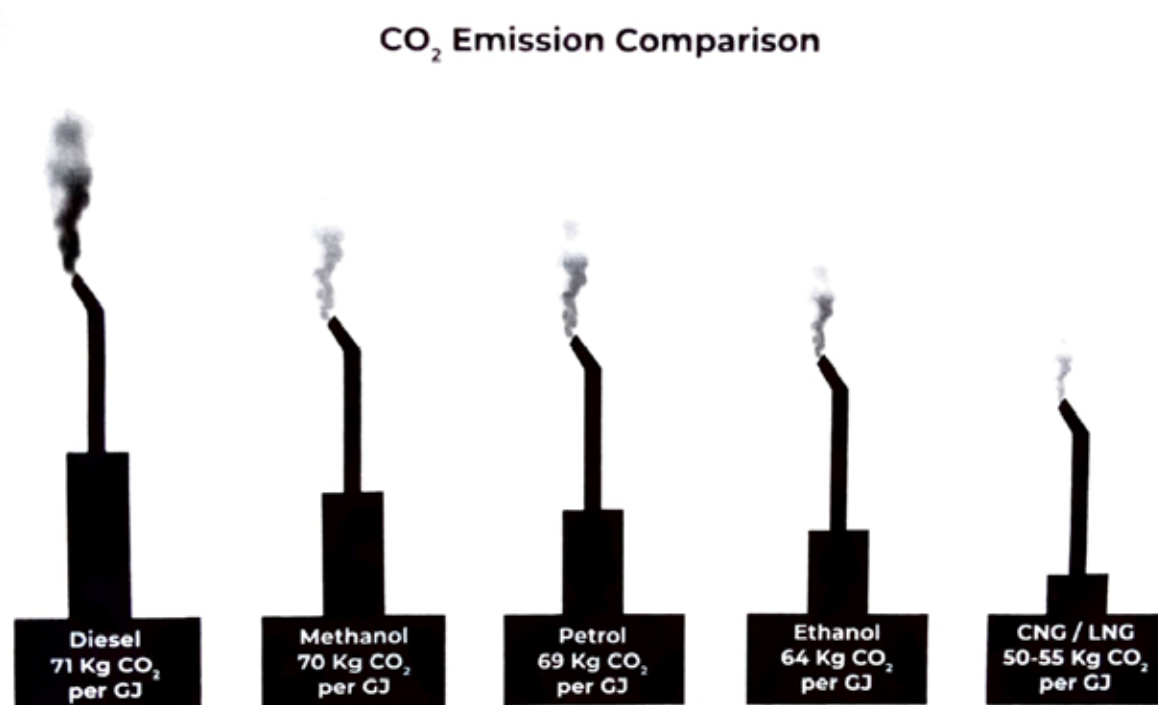
* Hydrogen Storage for Energy Application written by Rahul Krishna, Elby Titus, Maryam Salimian, Olena Okhay, Sivakumar Rajendran, Ananth Rajkumar, J.M.G. Sousa, A.L.C. Ferreira, Joao Campos Gil and Jose Gracio, published on September 5th, 2012.

Transition from Fossil Fuel - Dr. J P Gupta

India has a large growing population and economy, but comparatively has limited availability of fossil fuels to fulfill its energy demands. The key point to consider here is the ever-increasing fuel demand and its dependency on imported crude oil for domestic needs. India's annual energy import cost is in excess of USD 119.2 billion in 2021. More than 82% of this cost is consumed in importing crude oil and natural gas.

Fossil Fuel	Production in India (MMT)	Import (MMT)	Import (%)	Import Bill (\$ BN)	Import Bill (INR)
Crude Oil	34.2	226.6	83.7 %	112	8.17 lakh crores
LNG	24.8	20.7	47.2 %	10.3	21,888 crores

Source: Ready reckoner snapshot of India's oil and Gas data 2018-19.



Source: U.S. Energy Information Administration

Contd/-

As per the International Energy Agency, India will be importing 90% of its consumption by 2040. To reduce the environmental pollution and petroleum imports in India, there is a need to look for an alternate source of clean energy to meet the requirement.

We may look at solar PV and wind which have revolutionized India's green energy sector in the past decade. Diversification of electricity sources by integrating renewable energy in its grid is helping India in achieving the Paris agreement targets. The country has pledged to achieve 40% installed capacity from renewable energy sources by 2030 and reduce emissions intensity by 33-35% below 2005 levels in its nationally determined commitments to the 2015 Paris agreement.

Green Hydrogen – The National Agenda

Prime Minister in his Independence Day speech (15, August 2021) has announced five key initiatives, the first being Mission Hydrogen. He outlined a vision of becoming a global leader and enabling a substantial domestic hydrogen economy. Hydrogen has the promise of transforming India from an energy-deficient to an energy-rich country. It can even make India a net exporter of energy. In February 2022, India made a big splash in the hydrogen ecosystem by announcing its Green Hydrogen Policy. The policy takes ahead the vision articulated by Prime Minister Narendra Modi, to make India the global hub for the production and export of Green Hydrogen. The policy is based on a number of incentives for investors to use this new age fuel and gradually move away from traditional sources of energy.

Hydrogen is considered one of the most sustainable fuels of the future. When hydrogen is burned, we get water vapour, with no residue or climate-harming impact. The challenge has been to make "green hydrogen", which was the thrust of the Prime Minister's proclamation. For it, a lot of energy for the electrolysis of water is needed. Unless this electricity is produced with a zero-carbon footprint (i.e., with solar or wind), it defeats the key aspect of 'green' hydrogen. All other modes that do not use electrolysis to break a molecule of water are methods where hydrogen is produced as a by-product, or through a carbon burning process. The success of a massive breakthrough for scalable hydrogen production must be seen in confluence with factors like declining costs, financial incentives and carbon taxes, as happened for the breakthrough of other renewables. It seems like a global breakthrough is about to happen at this very moment. Thankfully, India is blessed with a clear minded Prime Minister, all-year sunshine and a large coastline. About 5,000 trillion kWh per year of energy is transferred from the sun to India's land area with most parts receiving 4-7 kWh per sq. m per day. In India, an average of 300 sunny days a year, can effectively be harnessed by solar photovoltaics' power, to provide huge scalability. This showcases the very high potential for production of Green Hydrogen energy in India. Solar-to-hydrogen also solves an intermittence challenge, as hydrogen has the potential to reduce/substitute the need for battery storage.

Opportunities for Green Hydrogen

Based on India's current progress in the renewable energy sector, it is clear that green hydrogen will make a greater impact on India's overall energy sector. Green hydrogen will help to provide a sustainable solution for the Indian industrial sector. India has fewer reserves of natural gas and green hydrogen production from renewables can make a difference in this scenario. Under the 'Make in India' program, India has the opportunity to start the production of electrolyzers and fuel cells which will allow capturing a large share in this market worldwide. As compared to other parts of the world, India has lowest cost of electricity from the solar photovoltaic systems, this generated power in the future will be helpful to scale up green hydrogen production. Water consumption by electrolyzers will be an issue of concern. Electrolyzers consume about 9 liters of water to produce 1 kg of hydrogen. In this scenario, seawater electrolysis (being availability of large coastline in India) will be of great interest that requires further development and research work. The existing hydrogen infrastructure needs to be strengthened for the larger acceptance of fuel cell vehicles. For further developments, hydrogen refuelling stations are required to be created and will play promising role.

The concept of Green hydrogen economy brings many opportunities for India to become energy independent. For the last decade, India is constantly focusing on growing its renewable energy capacity by taking advantage of its geography. Since hydrogen is expected to be an integral part of the energy system of the future, at an overall level, it seems logical to proceed in the planning with scaling of renewable energy in connection with scaling of hydrogen production. India can take the advantage of its renewable energy scenario and can scale up its hydrogen production facilities. The mass production offers India an opportunity to export green hydrogen to other nations in the long term, after meeting its own needs to replace fossil fuels. Green Hydrogen when used with fuel cells can help India significantly reduce its petroleum imports and environmental pollution.

Today green hydrogen is viewed as a very much promising energy carrier for achieving net-zero emission targets as it does not emit GHG upon combustion. Its inherent chemical characteristics, multiple end-uses, and harmony with other fuels and energy carriers make it a strong contribution to electrification, battery storage systems, carbon, capture, utilization, and storage (CCUS), bioenergy, etc.

At present, hydrogen is being primarily produced with the help of fossil fuels for use in the chemical, steel, and refinery industry. Today, it is possible to produce hydrogen with the help of renewable energy-based electricity. The 'net-zero-ness' of hydrogen depends on the method of production. Steam Methane Reforming (SMR) incurs a measurable amount of emissions when used for producing hydrogen (Hydrogen produced with such process is called grey hydrogen).

Green hydrogen (made from water and green electricity using an electrolyzer) is considered the next big movement toward sustainable development. It has found relevance in today's energy policy narrative, given its ability to decarbonize 'hard-to-abate' industries. Hard-to-abate sectors (like the steel industry) require a significant higher investment into green technology compared to the existing cost of carbon-based technologies, in the short term.

Hydrogen needs to be considered as complementary to its alternatives rather than contemplating it as an ultimate and stand-alone solution as it comes with its own constraints. The present storage and transportation technologies are expected to be mature and cost-effective by 2030. Hence, the production and near-real-time utilization of hydrogen at the same location can be promoted to safeguard investments against undesirable sunk costs.

Production of green hydrogen requires water and renewable electricity as input to the electrolyzer. The availability of sufficient water streams is critical as it is a valuable and limited resource having multiple application areas. Desalination plants can be set up to process wastewater or seawater for electrolysis to avoid possible water usage conflicts. Freshwater from such desalination plants can also be provided to the local population if the plants are set up in water scarce regions. Green hydrogen as an energy sector can become a reality in India if the large availability of renewable and water resources is used optimally.

India's Efforts about the hydrogen economy

India's ambitious plans of installing 450 GW of renewable energy capacity will fuel its drive to become the global hub of green hydrogen manufacturing.

CNBC-TV18 has reported from sources that a Rs 15,000-crore production-linked incentive (PLI) scheme was being worked on to push for electrolyser manufacturing in India. The scheme is expected to run for a period of five years, starting from FY24 with possible certain tax benefits. The ultimate aim of the government is to bring down the cost of green hydrogen to \$1 per kg and have five million metric tons per annum (MMTPA) green hydrogen capacity by 2030 in India.

India's largest company Reliance Industries Limited and its Chairman Mukesh Ambani has announced that the green Energy Giga Complex will have an electrolyser factory for green hydrogen production, and a fuel cell factory. He hopes that India can bring down hydrogen costs massively in the future. RIL hopes to become a net-zero emissions company by 2035, and a Rs 75,000-crore investment in green energy is a large part of the plan.

"Green hydrogen is the best and cleanest source of energy, which can play a fundamental role in the world's decarbonisation plans. Efforts are on globally to make green hydrogen the most

affordable fuel option by bringing down its cost to initially under \$2 per kg. Let me assure you all that Reliance will aggressively pursue this target and achieve it well before the turn of this decade. And India has always set and achieved even more audacious goals. Am sure that India can set an even more aggressive target of achieving under \$1 per kg within a decade. This will make India the first country globally to achieve \$1 per 1 kilogram in 1 decade – the 1-1-1 target for green hydrogen," he said.

Way forward

Renewable energy in India provides the opportunity to produce green hydrogen and to develop hydrogen infrastructure. To achieve a quick and safe adoption, many challenges still need to be solved. These challenges include hydrogen production cost, storage, transportation, policies, regulations, public awareness, etc. These can be resolved with Chain of world class Indian R & D Institution and with International Cooperation. The world is slowly moving towards the adoption of a Hydrogen economy and India is also taking important initiatives. Indian organizations, including both government and public are investing in the research of hydrogen technologies. Many ongoing research and demonstration projects are very important to develop hydrogen and fuel cell technology economically. The progress in this development will play a key role in the commercialization of the technology.

As Indian businesses invest in research and development across the entire green hydrogen value chain, the lack of a homegrown research workforce will become a bottleneck. Addressing this challenge will not only require serious investment in universities to scale up their research and research training programs but also strong incentives for collaboration between academia, corporate labs and public research institutions. When universities are an integral part of the national research enterprise, they produce human capital aligned with national economic needs which has a long-term multiplier effect in sustaining innovation.

As the Indian Industries are to make Key strides toward decarbonization, the entire industrial sector needs to be brought under the decarbonization umbrella. They will need strong political backing, steady investment and receptiveness for innovation and change. Industrial decarbonization will transform India to a sustainable future.

No country needs green hydrogen more than India – to reduce life-threatening air pollution in its cities, to escape the debilitating financial burden of energy imports, and to decarbonize its rapidly growing economy. No country has a more urgent need to fast-track the green hydrogen economy and lead the way than India.



Mr Mahendra Rustagi
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Committee, PHDCCI

Environmental, Social and Governance (ESG)

The landscape is charged, the horizon is tainted, and the sun never quit touches the surface. World over, there is realization about the importance of meeting ESG and Net Zero Goals. During the last COP 26 held in November 2021 at Glasgow, India has given commitment to be carbon neutral by 2070. Bringing up the share of Renewable energy to 50 % of the total energy usage by 2030 is also one of the major commitments given.

Commitments given by the Government is backed by numerous action points for the Government has been issuing guidelines and notifications on many fronts including regulating business impact on environment and society.

One of the many initiatives towards environment protection is allowing up to 20% ethanol – petrol mix . In fact 10% ethanol petrol mix is already achieved 5 months before the deadline of November 2022. This has reduced the carbon emission by 2.7 Million Tons which has saved the country 5.5 Bn \$ on oil imports and also boosted the farmers income by over 5 Bn \$ in last 8 years .

There are three Postulates of creation, Environment, Society and Business. ESG is an interwoven matrix for doing business having due consideration for environment and society. ESG matrix helps in a more equal / fair distribution of benefits to the society at large without compromising the business objects of the organisation Environmental, Social and Governance are a set of standards devised to structure the organisation's behaviour toward Environment, communities and all the stakeholders affected by the organisation's activities.

Business done so far has neither taken care of the environment nor of the society at large. ESG is an interwoven matrix for doing business having due consideration for environment and society. ESG matrix helps in a more equal / fair distribution of benefits to the society at large without compromising the business objects of the organisation.

It is about development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Businesses can develop sustainability and ESG Strategies that achieve net-zero and circularity goals in compliance with 2050 targets remain profitable while maintaining access to financing through banks and capital markets.

Sustainability in the business means creating balance between 3 Ps namely People, Planet and Profit. All these 3 elements need to co-exist for sustainable development. It can only be when business is Equitable to the People / Society, bearable for the Planet and also most importantly viable / profitable at the same time .



The government of India has taken various steps to safeguard the environment. Some of the steps are Swachh Bharat Mission, Green Silk Development Programme, Namami Gange Program, Compensatory Afforestation Fund Act (CAMPA), National Mission for Green India, National River Conservation Programme, Conservation of Natural Resources and Eco-systems.

To assess and communicate the impact of organisation on parameters of environmental, society and corporate governance Global Reporting Initiative (GRI) was founded in Boston to provide independent standards, in 1997.

In 2015, at the United Nations Framework Convention, COP 21, the Paris Agreement was brought to life, and at the United Nations General Assembly the Sustainable Development Goals were created. The 2021 United Nations Climate Change Conference, COP26 was the 26th United Nations Climate change conference. The result of COP26 was the Glasgow Climate Pact, negotiated through consensus of the representatives of the 197 attending parties.

According to the European Green Deal, by 2050, all member states will have circular economies, having achieved net zero emissions. While the European Union (EU) has a head start, the United States also has bold plans to decarbonize the economy and aim for net-zero emission target by 2050.

Since 2019, European investors poured €120 billion into sustainable investment and investors are increasingly interested in how existing companies and startups are scoring on their ESG policies options, demonstrating the rising importance of ESG in Corporate Planning. Venture Capitalists and practices the United Nations Conference on Trade and Development (UNCTAD) estimates that the value of sustainability-related investment instruments (such as green bonds) reached between \$1.2 trillion and \$1.3 trillion in 2019 . Greenfield FDI in renewable energy totalled \$85.5 billion globally in 2020, hitting new highs and eclipsing FDI in fossil fuels for the first time.

In India, the journey of ESG is much more recent. It started in 2011 with the framing of National Voluntary Guidelines on Social, Environmental & Economic Responsibilities of Business (NVGs). BRR disclosure were mandatory for Top 1000 companies by market capitalization from Financial Year 2018-19. The name was changed to Business Responsibility and Sustainable Reporting (BRSR) from 2020. BRSR was voluntary for Financial Year 2021-22 but has become mandatory for Top 1000 listed.

At the United Nations Framework Convention, COP 21, the Paris Agreement is brought to life, and at the United Nations General Assembly the Sustainable Development Goals, 17 in numbers were created. These Goals are common for all the countries for a sustainable development, these goals inter alia include Poverty, hunger , education , health , peace , justice , gender equality etc etc.

ESG need is established beyond the statutory requirement. Business Responsibility and Sustainability Report which top 1000 listed companies are required to issue every year is an initiative towards ensuring that investors have access to standardized disclosures on ESG parameters. Proven effects include smoother operations, positive morale and market enthusiasm for the ethical stance of the company. Making investments in ESG can produce positive results beyond solid financial performance.

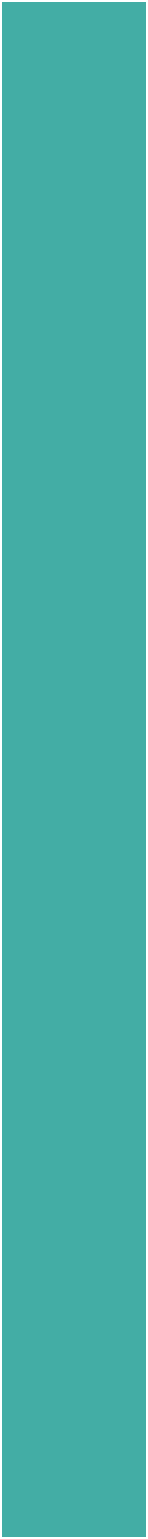
ESG Compliance and Reporting creates a good public relations story and helps in building a stronger corporate brand. A robust ESG program can open up access to large pools of capital. Fund managers use ESG considerations to identify risks and opportunities that could affect a firm's long-term sustainability. Many Corporates put ESG Compliances as a precondition to business relationships and tie-ups. Also the Government is likely to provide incentives to businesses in form of subsidies and differential interest rates for achieving ESG goals and committed by our Prime Minister in COP 21 summit.

ESG has become an integral part of business operations and an important part of all future investment decisions. With more and more organizations adopting strict ESG Policies for investing and vendor selection, it will become very difficult for organizations, not adopting ESG, to compete and survive.

Further, a strong ESG proposition helps companies to -

- tap new markets and expand into existing ones leading to strong growth..
- attract and retain quality employees, enhance motivation and increase productivity overall
- better brand appreciation and loyalty towards products of ESG compliant companies thereby allowing them better pricing and valuations.
- better customer loyalty and premium pricing of product and organisations pursuing good ESG Practices can help companies achieve higher profits and consumer satisfaction.
- achieve greater strategic freedom, easing regulatory pressure , it helps reduce companies' risk of adverse government action. It can also engender government support.
- enhance investment returns by allocating capital to more promising and more sustainable opportunities (e.g. renewables, waste reduction etc
- Lower energy and water consumption contributes to cost reduction and profit maximisation.

An analysis by CRISIL research reveals that 20% of 586 indian companies assessed come under strong and leadership matrix . And nearly 80 % companies got placed as weak / below average . However , the silver lining is that most companies saw improvement in their ESG scores , driven by better disclosure and improved performance on various parameters . Leaders on ESG



demonstrated a clear commitment towards sustainability , and have continuously delivered superior performance. In contrast those in the weak category have poor disclosure and inadequate ESG risk management practices.

The consideration of ESG in the decision making is very low because of lack of fiduciary commitment for ESG quotient .For ESG to be truly embedded and practiced in spirit , all the stakeholders will have to work collaboratively. A mindful shift is necessary to transform from merely complying to creating value . The performance of companies on the environmental parameter are weaker , compared with social and governance , as per the study by Crisil.

On social aspects , public sector undertakings fared better than private companies. PSUs fared better on key parameters , such as gender diversity , attrition and pay disparity . On Governance practices , especially board composition (women directors / independent directors) and functioning , Private sector companies fared better .

ESG is for business organization what ECG is for Heart. ESG is now becoming a measure of health and pulse of business organizations and a must for survival of the business.

GREEN HYDROGEN - OPPORTUNITIES IN INDIA



Dr J S Sharma

Co-Chair, Environment Committee, PHDCCI
STA Fellow (Environment), AIST, Govt. of Japan
Formerly Group General Manager and Head
Environment, ONGC, New Delhi

India has a large growing population and economy, but comparatively has limited availability of fossil fuels to fulfill its energy demands. The key point here to consider the ever-increasing fuel demand and its dependency on imported crude oil for domestic needs. India's annual energy import cost is in excess of USD 119.2 billion in 2021. More than 82% of this cost is consumed in importing crude oil and natural gas. To reduce the environmental pollution and petroleum imports in India, there is a need to look for an alternate source of clean energy to meet the requirement. We may look at solar PV and wind which have revolutionized India's green energy sector in the past decade. Diversification of electricity sources by integrating renewable energy in its grid is helping India in achieving the Paris agreement targets. Recently on August 03, 2022, the Union Cabinet, Govt. of India has approved India's Updated Nationally Determined Contribution under the Paris Agreement which is to be communicated to the United Nations Framework Convention on Climate Change. According to the updated NDC, India now stands committed to reducing emissions intensity of its GDP BY 45 per cent by 2030, from 2005 level, and achieving about 50 per cent cumulative electric power installed capacity from non- fossil fuel-based energy resources by 2030. A step forward to meet Net Zero target by 2070.

Green Hydrogen – The National Agenda

Prime Minister in his Independence Day speech (15 ugust,2021) has announced five key initiatives, the first being Mission Hydrogen. He outlined a vision of becoming a global leader and enabling a substantial domestic hydrogen economy. Hydrogen has the promise of transforming India from an energy-deficient to an energy-rich country. It can even make India a net exporter of energy. In February 2022, India made a big splash in the hydrogen ecosystem by announcing its Green Hydrogen Policy. The policy takes ahead the vision articulated by Prime Minister Narendra Modi, to make India the global hub for the production and export of Green Hydrogen. The policy lays out incentives for investors to use this new age fuel and gradually move away from traditional sources of energy.

Hydrogen is considered one of the most sustainable fuels of the future. When hydrogen is burned, we get water vapour, with no residue or climate-harming impact. This has to do with a confluence of factors like declining costs, breakthroughs in technology and carbon taxes, as happened for other renewables. The challenge has been to make “green hydrogen”, which was the thrust of the Prime Minister’s proclamation. For it, a lot of energy for the electrolysis of water is needed. Unless this electricity is produced with a zero-carbon footprint (i.e. with solar or wind), it defeats the key aspect of ‘green’ hydrogen. All other modes that do not use electrolysis to break a molecule of water are methods where hydrogen is produced as a by-product, or through a carbon burning process. Thankfully, India is blessed with all-year sunshine. About 5,000 trillion kWh per year energy is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day. In India, an average of 300 sunny days a year, the Solar photovoltaics power can effectively be harnessed providing huge scalability in India. This very clearly indicates that there is a very high potential of harnessing the Green Hydrogen energy in India. Solar-to-hydrogen also solves an intermittence problem, as hydrogen substitutes the need for battery storage.

Opportunities for Green Hydrogen

Opportunities for India Based on India’s current progress in the renewable energy sector, it is clear that green hydrogen will make a greater impact on India’s overall energy sector. Green hydrogen will help to provide a sustainable solution for the Indian industrial sector. India has fewer reserves of natural gas and green hydrogen production from renewables can make a difference in this scenario. Under the ‘Make in India’ program, India has the opportunity to start the production of electrolyzers and fuel cells which will allow capturing a large share in this market worldwide. As compared to other parts of the world, India has a low cost of electricity from the solar photovoltaic systems, this generated power in the future will be helpful to scale up green hydrogen production. Water consumption by electrolyzers will be a issue of concern. Electrolyzers consume about 9 liters of water to produce 1 kg of hydrogen. In this scenario, seawater electrolysis (being availability of large coastline in India) will be of great interest that requires further development and research work. The existing hydrogen infrastructure need to be strengthened for the larger acceptance of fuel cell vehicles. For further developments, hydrogen refueling stations are required to be created and will be play promising role.

Considering the aforementioned situation in background, the need to search for an alternate fuel, the context focuses on the opportunities offered by Green Hydrogen Economy. The concept of Green hydrogen economy brings many opportunities for India to become energy independent. For the last decade, India is constantly focusing on growing its renewable energy capacity by taking advantage of its geography. Integrating hydrogen production with these renewables can scale up the green hydrogen production in India.

India can take the advantage of its renewable energy scenario and can scale up its hydrogen production facilities. The mass production offers India an opportunity to export green hydrogen to other nations. Green Hydrogen when used with fuel cells can help India significantly reduce its petroleum imports and environmental pollution.

Renewable energy in India provides the opportunity to produce green hydrogen and to develop hydrogen infrastructure but for adoption, many challenges still need to be solved. These challenges include hydrogen production cost, storage, transportation, policies, regulations, public awareness, etc. These can be resolved with Chain of world class Indian R & D Institution and with International Cooperation. The world is slowly moving towards the adoption of a Hydrogen economy and India is also taking important initiatives. Indian organizations which include both government and public are investing in the research of hydrogen technologies. Many Ongoing research and demonstration projects are very important to develop hydrogen and fuel cell technology economically. The progress in this development will play a key role in the commercialization of the technology.

Today hydrogen is viewed as a very much promising technology for achieving net-zero emission targets as it does not emit GHG upon combustion. Its inherent chemical characteristics, multiple end-uses, and harmony with other fuel and energy carriers make it a strong contender of the clean energy transition apart from electrification, battery storage systems, carbon, capture, utilization, and storage (CCUS), bioenergy, etc.

At present, hydrogen is being primarily produced with the help of fossil fuels for use in the chemical, steel, and refinery industry. Today, it is possible to produce hydrogen with the help of renewable energy-based electricity. The 'net-zero ness' of hydrogen depends on the method of production. Steam Methane Reforming (SMR) incurs a measurable amount of emissions when used for producing hydrogen (Hydrogen produced with such process is called gray hydrogen). Green hydrogen (made from water and green electricity using electrolyzer) is considered the next big movement toward sustainable development. It has found relevance in today's energy policy narrative, given its ability to decarbonize 'hard-to-abate' industries. Hard-to-abate sectors (like the steel industry) require a significant investment of green technology than existing carbon-based technologies.

Hydrogen needs to be considered as complementary to its alternatives rather than contemplating it as an ultimate and stand-alone solution as it comes with its own constraints. The present storage and transportation technologies are expected to be mature and cost-effective by 2030. Hence, the production and near-real-time utilization of hydrogen at the same location can be promoted to safeguard investments against undesirable sunk costs.

Production of green hydrogen requires water and green electricity as input to the electrolyzer.

The availability of sufficient water streams is critical as it is a valuable and limited resource having multiple application areas. Desalination plants can be set up to process wastewater or seawater for electrolysis to avoid possible water usage conflicts. Freshwater from such desalination plants can also be provided to the local population if the plants are set up in water scarce regions. Green hydrogen as an energy sector can become a reality in India if the large availability of renewable and water resources are used optimally.

India's Efforts about the hydrogen economy

India's ambitious plans of installing 450 GW of renewable energy capacity will only fuel its drive to become the global hub of green hydrogen manufacturing.

CNBC-TV18 has reported from sources that a Rs 15,000-crore production-linked incentive (PLI) scheme was being worked on to push for electrolyser manufacturing in India. The scheme is expected to run for a period of five years, starting from FY24 with possible certain tax benefits. The ultimate aim of the government is to bring down the cost of green hydrogen to \$1 per kg and have five million metric tons per annum (MMTPA) green hydrogen capacity by 2030 in India. India's largest company Reliance Industries Limited and its Chairman Mukesh Ambani has announced that the green Energy Giga Complex will have an electrolyser factory for green hydrogen production, and a fuel cell factory. He hopes that India can bring down hydrogen costs massively in the future. RIL hopes to become a net-zero emissions company by 2035, and a Rs 75,000-crore investment in green energy is a large part of the plan.

"Green hydrogen is the best and cleanest source of energy, which can play a fundamental role in the world's decarbonisation plans. Efforts are on globally to make green hydrogen the most affordable fuel option by bringing down its cost to initially under \$2 per kg. Let me assure you all that Reliance will aggressively pursue this target and achieve it well before the turn of this decade. And India has always set and achieved even more audacious goals. Am sure that India can set an even more aggressive target of achieving under \$1 per kg within a decade. This will make India the first country globally to achieve \$1 per 1 kilogram in 1 decade – the 1-1-1 target for green hydrogen," he said.

Way forward ;

Renewable energy in India provides the opportunity to produce green hydrogen and to develop hydrogen infrastructure but for adoption, many challenges still need to be solved. These challenges include hydrogen production cost, storage, transportation, policies, regulations, public awareness, etc. The world is slowly moving towards the adoption of a Hydrogen economy and India is also taking important initiatives. Indian organizations which include both government and public are investing in the research of hydrogen technologies. Many Ongoing research and

demonstration projects are very important to develop hydrogen and fuel cell technology economically. The progress in this development will play a key role in the commercialization of the technology. Well-developed fuel cell technology and locally produced green hydrogen will be key players to decarbonize the Indian transport sector by replacing the current petroleum-based vehicle engines.

As Indian businesses invest in research and development across the entire green hydrogen value chain, the lack of a homegrown research workforce will become a bottleneck. Addressing this challenge will not only require serious investment in universities to scale up their research and research training programs but also strong incentives for collaboration between academia, corporate labs and public research institutions. When universities are an integral part of the national research enterprise, they produce human capital aligned with national economic needs which has a long-term multiplier effect in sustaining innovation.

As the Indian Industries to make Key strides toward decarbonization , the entire industrial sector needs to be brought under the decarbonization umbrella with strong political backing, steady investment and receptiveness for innovation and change ,industrial decarbonization will transform India to a sustainable future.

No country needs green hydrogen more than India – to reduce life-threatening air pollution in its cities, to escape the debilitating financial burden of energy imports, and to decarbonize its rapidly growing economy. No country has a more urgent need to fast-track the green hydrogen economy and lead the way than India.



Mr Umesh Sahdev
Executive Chairman,
Hydrogenium Resources
Pvt. Ltd

Ancient Wisdom and Sustainable Development

Climate change and global warming is real, now proven that it is caused by human activities and that it is accelerated by the burning of fossil fuels.

As of early September 2015, the average global temperature has risen 1.4 degrees Celsius since 1880, and nine of the ten hottest years on record have occurred since 2000. Carbon dioxide stands at 400.84 parts per million, the highest levels the Earth has experienced in 650,000 years. Since March 2022 there has been unusual rise of temperature surpassing 470 C, first time ever, in certain Northern parts of India.

Evidence from ocean sediments, ice cores, tree rings, sedimentary rocks and coral reefs show that the current warming is occurring 10 times faster than it did in the past when Earth emerged from the ice ages, at a rate unprecedented in the last 1,300 years.

Humans' dependence on fossil fuels, economy of consumption, achieving ever-higher profits and continuous growth, are all part of the dream of the modern world. For decades, we've assumed that, in the face of development, the destruction of nature is inevitable. We allowed tree-felling in favour of luxury apartment complexes or ignore the razing down of critical forests to make way for highways. But the scarily reducing amounts of forest cover, the high rates of pollution, and unbearable weather shifts have put paid to that. We have and even still now acting in certain ways that drive global warming and put life on Earth—not only human life but that of all plants and animals as well—at risk.

However, the world is finally waking up to the stark reality that we can no longer degrade nature for development or stand neutral ground. To restore some semblance of balance, whatever we create next must add to nature.

Now, the search for a new paradigm – Sustainable Growth or just Sustainability, that can ensure economic development without jeopardising environmental quality is being intensified. World seeks to establish a philosophical foundation where people think about nature before thinking about themselves, which can make us realise the deeper underlying reality of basic oneness. Natural Science doesn't simply describe nature, it is part of the interplay between nature and mankind. This ecological harmony is possible when the entire universe is seen as a single largest family including all the living beings of the world. Vedic civilization realised this world view when they say, 'vasudhaiva kutumbakam.' This world view further developed in the Upani-adic age with a firm philosophical foundation through its cosmological unity and sustainability.

Such a holistic world view offers a new paradigm for development, a new socioeconomic system free from exploitation, defining in a novel way the relationship between man and nature thus realising the ecological balance we need today.

Sustainability, however, is often viewed through a futuristic prism, yet what we often miss out is that ancient wisdom can hold important lessons. The struggle to be more sustainable is a relatively new phenomenon, but inspiration can be drawn from ancient farming and water management techniques. Innovation and technology can help us adapt these techniques to meet our present-day needs.

When we think of “innovation” and “technology,” we probably link it directly to modernity, futurism, and industrial development. The word that probably won't make the list is “ancient.” And yet, ancient natural technologies might well give us the answer to adapting to climate change that we desperately seek in modern innovations. Ancient wisdom can guide and teach us more sustainable infrastructure without exploiting or outright destroying nature. In responding to climate change with complex infrastructures and monotonous high-tech design, we're forgetting that we are sitting on a goldmine of millennium old knowledge — about living in symbiosis with nature and striking a balance between growth and harmony.

The Ancient Wisdom has always been in the world. It is knowledge of the nature of things and of human nature. It is the Wisdom of understanding and compassion, of which all of us feel in need in the depths of our being. One way to shift our focus and incorporate a more Earth-friendly (and life-friendly) way of living into our everyday lives, is to weave together modern knowledge and ancient wisdom

While we may not be able to resurrect everything, we left in the past but it's worth understanding that some ancient innovations and processes might still serve us well. The point of looking both forward and backwards is to arm ourselves with a wide range of tools to adapt to climate change. It isn't loud claim but numbers of countries around the world are looking to ancient wisdom

for guidance and have reached levels of innovation that perfectly balance what was previously considered un-balanceable.

Some of the examples that elucidate how ancient knowledge ne ancient wisdom is being utilised : – a study found that Tibetans living in Himalayan region are very susceptible to climate change, yet the people utilize a wide range of ecological zones for their subsistence.

Many other studies are underway and being conducted to determine how we, the mankind can utilize this type of wisdom on a global scale.

Extreme weather has impacted played havoc with farmers across globe, while some are started adopting new technologies, others are looking back to explore old processes that worked then. Keith Elverson, expert of UNEP says there is probably no ‘silver bullet’ to solve everything but to look both forward and backwards to develop a wide set of tools as we adapt.

Below are some of the examples of such adaptations and utilizing ancient wisdom in the various part of world, it’s fascinating to read about lost ancient wisdom:

‘Floating Rice’ of Vietnam Mekong Delta where farmers were shown by a researcher Nguyen V K as how to work un-conventionally against intense floods and swamps to grow high yield variety and rediscovering ancient grains. Floating rice has become well adapted to floods as the foliage grows much more than the level of floods.

Harvesting rainwater, the ancients seem to have mastered the art of harvesting rainwater, diverting it from two ephemeral channels and then storing it in large reservoirs built on the site.

In Bhuj itself, the group called Arid Communities and Technologies (www.act-india.org), has been working for long in understanding the traditional water harvesting and management system at Bhuj and they tried reviving it with the help of local communities. A small old well recently cleaned up by people voluntarily is now supplying water to about 50 families.

In Kolkata, India, BHERI waste water aquaculture system management is the innovation in organic technology that has made its way to no of countries to do organic aquaculture and use waste water in a sustainable. It features ~300 fishponds that carry out chemical-free water purification by relying on combination of bacteria, algae, sewage, and sunshine instead of coal-based power. It’s also a source of food, an agricultural field, and a way of cleaning wastewater before it enters the Bay of Bengal.

There are other ancient techniques as well like using ducks instead of pesticides for managing insects etc. In Heilongjiang, China, Fang Yongjiang, a farmer, thought up a chemical-free

approach that required no technology — only the clever thinking of ancestry 600 years introduced ducks into rice paddies to feed on the weeds and insects so pesticides wouldn't be needed. Their droppings doubled up as natural fertilizer, which was a win-win. Fang initially began with a handful of ducks over 25 acres. In just a few years, other rice growers also implemented the ancient wisdom to bring the number up to 500 acres of pesticide- and fertilizer-free rice paddies monitored by ducks.

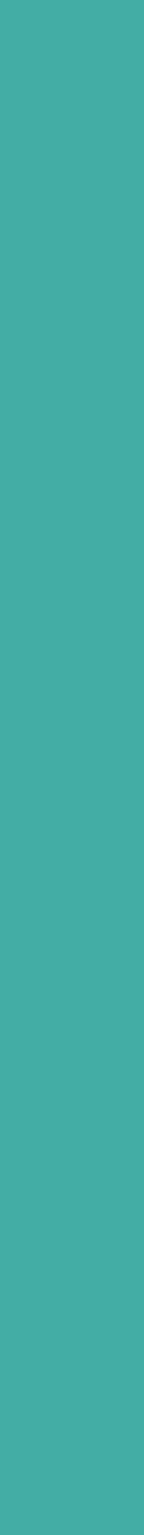
In Bolivia, Oscar Saavedra's non-profit, Sustainable Amazonia, has taught 500 families a method of agriculture back from 400 BC — 7-foot high elevated fields that stood higher than floodwater levels and were surrounded by canals. During flood season, the canals would hold the water to prevent the fields from flooding. During droughts, the same nutrient-rich canal water would be used to irrigate the fields.

By going back to the culture of the open well, by using only the dynamic water table, by recharging aquifers, and by reserving the deeper aquifers for droughts and other emergencies we can hope to tide over droughts in the era of climate change. This is the water wisdom which we must learn from our ancients.

Many of ancient innovations are absolutely in tune with nature, using available resources smartly to create a mutually beneficial relationship. They might be simple or complex, but usually, they're already there in our history books if we took a closer look. As they say, history repeats itself — and a lot of our modern problems were also faced by ancestors when their times were considered “modern.”

The Borana, a cattle-herding tribe in Kenya, is surviving droughts in arid Isiolo County by reintroducing an abandoned, centuries-old traditional grazing management method. Called “Dedha” (which means “council” in the local dialect), the system relies on placing decision-making authority in the hands of the elders who ensure that all herders have adequate pasture and water for their animals. Since Dedha was reinstated in 2011, the Borana have lost fewer animals to drought, according to Victor Orindi of the Adaptation Consortium, a group that works to mitigate the effects of climate change in Kenya. Conflicts over natural resources have also been reduced, he adds. The county is in the process of passing legislation that will officially recognize the authority of Dedha councils.

Projects like AIUla's Cultural Oasis in Saudi Arabia are trying to integrate lessons from the past to create a more sustainable future for areas in need of development. These ancient techniques are being updated with new technology and innovative thinking to address sustainability issues such as desertification.



The Azawak region of West Africa has badly suffered from desertification and water scarcity due to the impact of climate change. The water crisis has had a severe impact on both the local environment and the traditional nomad communities who farmed it.

NGO Amman Imman is using water harvesting methods to restore ecosystems to improve the livelihoods of those forced to migrate.

On the concluding note - large part of world's remaining ecosystems is in the hearts of the lands of indigenous people. For millennia, they've lived in harmony with nature without giving up on progress - and that goes to show that there is hope for environmentally-friendly solutions to modern problems through ancient wisdom.

Ecology depends on the interdependence of multiple processes and schools of thought, so it's impossible to say that there's one right way to tackle all of the world's environmental problems.. The smart way to go about adapting to climate change is to listen to those who've shown resilience in the face of it for years and reach a happy balance.

No matter where we live, we're all still dependent on the same web of life. There is immense value in looking at solutions that succeeded in the past to see whether we can correct our course in time. Ancient Wisdom integrating with sustainability means not only integrating the economy with nature and society but also integrating the past with the present, the present with the future, and technology with culture.

ORGANIZERS



GREENSTAT
NORWAY



प्रौद्योगिकी विकास बोर्ड
TECHNOLOGY DEVELOPMENT BOARD
DEPARTMENT OF SCIENCE & TECHNOLOGY

OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

India - Norway Alliance on Hydrogen



Gexcon is a world-leading company in the field of safety and risk management and advanced dispersion, explosion and fire modelling. Gexcon (an acronym for Global explosion consultants) was founded in 1987 as a consulting brand of Christian Michelsen Institute. In 1998, Gexcon was established as a company providing advanced safety engineering software, consulting and fire and explosion testing services.

Its experience arises from detailed knowledge of explosion phenomena built up through years of extensive research projects, carrying out safety assessments, performing accident investigations and conducting physical testing at the company's facilities. A software suite based on 760 NOKM investment on scientific studies over the past 50 years, driven and encouraged by leading industry players wanting to cover a need for the highest safety requirements. Gexcon performed over 65 R&D projects and published 422 scientific publications since 1980.

Gexcon assist industries in identifying their hazards, understanding their risks, and contribute to improving their overall safety performance. It believes in a tailor-made and individual approach for each industry, and by working together, Gexcon will find the most optimal process to identify the company's needs to manage their most critical risks.

Due to its commitment and passion within process safety and risk management, Gexcon's position within this field has grown. Today, Gexcon is considered to be one of the global leaders and preferred partners to a multitude of industries including food, pharmaceutical, automotive, chemical, green energy solutions and oil and gas.

Gexcon is proud of its contribution to making the world a safer place. Keeping up with changes in technology, legislation and industry standards for best practices require continuous and dedicated efforts. GEXCON's vision is to develop reliable, efficient and user-friendly simulation tools for industrial use. Significant efforts are invested in validating the implemented models through experimental work and Joint Industry Projects (JIP). Gexcon work hard to be the preferred partner in dispersion, fire, and explosion safety as well as risk management to make this vision come true. Also, Gexcon is a proud contributor to the 17 UN sustainable development goals which aims to achieve a better and more sustainable future for all.

Gexcon develops, maintains and uses the industry-standard software for modelling gas explosions, FLACS®, along with the industry-standard tool for modelling dust explosions, FLACS-Dust Ex. Gexcon's FLACS Consulting Group represents one of the largest and most experienced group of individuals to provide the customer with assistance to make use of the information

which FLACS modelling can provide, adding significant value to the service it delivers.

In addition, Gexcon expanded its software solutions into a complete software suite by adding EFFECTS and RISKCURVES, a consequence and risk tools originally developed by TNO, as well as Shell FRED and Shell Shepherd, a consequence and risk tools developed by Shell and available exclusively through Gexcon.

Gexcon's headquarter is in Bergen, Norway and consists of four departments:

- R&D (responsible for development and maintenance of FLACS),
- Software (responsible for sale and support of FLACS),
- Laboratories (responsible for testing and experimental work),
- Consulting (performs CFD analyses based on FLACS as well as qualitative risk analyses)

Gexcon also have branch offices located in Perth (Australia), Shanghai (China), Paris (France), Pune and Mumbai (India), Jakarta and Bandung (Indonesia), Utrecht (the Netherlands), Moscow (Russia), Borås (Sweden), Dubai (UAE), Manchester (UK) and Houston, Bethesda and Houston (US).

Besides providing consultancy services within Gexcon's traditional core activities these offices host special competence in areas such as structural analysis and accident investigations.

For the last 50 years, Gexcon has been involved in the investigation of many high-profile accidents such as Buncefield, Piper Alpha, TWA 800, and the P-36 platform (Brazil). Its expertise includes site inspections using advanced techniques to map the environment, locate gas and vapour pathways, detect chemical residue, and collect and preserve physical evidence. Leaders in the oil and gas industry and safety engineers at major hazard facilities have consistently sought the services of Gexcon to provide them with its expertise to manage the risks of fire and explosions from flammable substances.

Gexcon India:

Gexcon India Pvt Ltd is a subsidiary company of Gexcon AS, a global knowledge and technology leader in advanced dispersion, fire and explosion safety, and risk management. Since 2016, Gexcon is operated in India.




Gexcon India Team with Gexcon Executive Leaders , Miss.Jale Cairney (CEO-Consulting, Gexcon), Mr. Paul Taylor (CEO – Software, Gexcon) and Mr. Rajendra Narkhede (Sr. Vice President) during India Visit in 2022.

Gexcon India have performed more than 100 Consequence analysis study (Ventilation/ Dispersion/ Explosion) and 50 study for Environmental Clearance studies using FLACS for domestic and international clients in addition numerous qualitative explosion risk analyses.

Due to the high applications, correct and validated modelling results several international oil and gas companies have made mandatory to use FLACS. Recently, Statoil Norway and ADNOC Middle East have adopted FLACS CFD guidelines and mentioned that FLACS study to be done for risk analysis. In India Reliance, Cairn and many more other industries have taken lead and developing such requirements

Emerging economies like India need to enhance their institutions and their infrastructure significantly and focus on prevention of accidents if they are to realise their long-term growth potential. Currently, there is no centralized system in India to document and investigate all chemical accidents. Gexcon Norway and India Executive leader Mr. Sturle Pederson (Chairman, Gexcon), Prof. Jan Roar Bakke (Executive Vice president, Gexcon) and Mr. Rajendra Narkhede (Senior Vice President, Gexcon India) has conducted a series of meetings and discussions on need



of CoE on process safety and risk management in India with Gol Ministries like MoEF, premium academic institutes like IIT's, IIP Dehradun, ICT Mumbai, and research Institutes like DRDO, CSIR NEERI Nagpur, ONGC Safety Institute Goa, and leading process industries, Process industries in various sectors- Chemicals, petrochemicals, and energy like Oil & Natural Gas Corporation Limited recognize Process Safety & Risk Management as an area with an enormous potential. There was unanimous agreement on the strong need for such a CoE in India. Further, all the participants exhibited keen interest to join hands to set up the CoE. In 2019, Gexcon India forms MoU with UPL Ltd., ICT Mumbai, CSIR NEERI Nagpur and IITD Delhi for CoE in process safety and risk management and Successfully established CoE in India to make India safe.

Greenstat Hydrogen India Private Limited

Greenstat AS aims to contribute to an emission-free society and does this by establishing and investing in projects and companies within renewable energy production, storage, distribution and consumption. Greenstat also delivers analysis and insights into the green energy markets, develops, and operates concepts for energy distribution through energy stations. The company is structured with subsidiaries managing each market.

Greenstat Asia manages early-stage project development in Asia/India, leaning on resources from the Greenstat organization. Specific focus on green hydrogen, through our Indian subsidiary Greenstat Hydrogen India PVT LTD. Greenstat Hydrogen India manages development of and operations in green hydrogen projects.

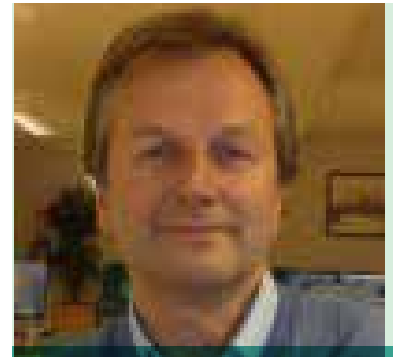
Greenstat Hydrogen India is an entity working under the leadership of strong industry professionals having knowledge on entire energy value, hydrogen system, and academia. Greenstat aims to work in the fields of.

- Green Hydrogen Production
- Green Ammonia Production
- Advisory services through Centre of Excellence- Hydrogen
- Maritime Transport
- Clean Hydrogen/Ammonia Transportation
- Policies and Standards



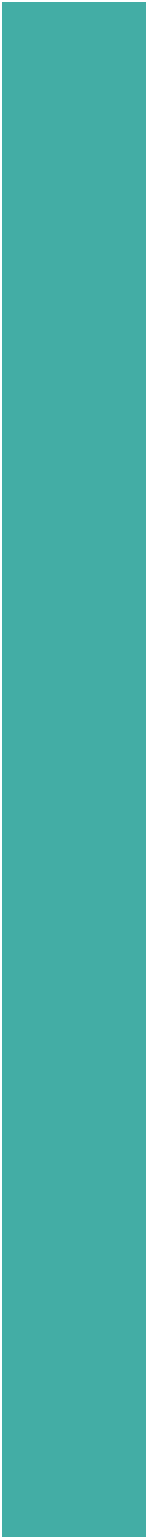
Vegard Frihammer

CEO & Founder,
GREENSTAT ASA



Sturle Harald Pedersen

Chairman,
GREENSTAT INDIA



Greenstat Hydrogen India Pvt. Ltd. is a part of The Greenstat Group, a Norwegian Green Energy and Technology company with its HQ in Bergen, Norway established in 2015 and has an ambition of becoming «the green Statoil». Our vision is "Making Green Happen" and the company works exclusively with green projects that contribute to a transition from fossil to renewable energy use. Christian Michelsen Research established Greenstat, and the largest owners were CMR, Trond Mohn and the University of Bergen. Greenstat has the following purpose clause: 'Greenstat focuses on local energy, production and export of green hydrogen and energy analysis/ consulting'.

Today there are about 2000 shareholders of Greenstat, where Aker Clean Hydrogen, a global integrated clean hydrogen, ammonia and methanol producer, is the largest one with approximately 20 per cent share. Greenstat, a green energy company, facilitates energy transition throughout the whole value chain of green hydrogen – from analysis to execution. We have tools that assist customers (public or private) in finding the best emission-free solutions, based on tailor-made assessments. Our analytical capabilities stretch from market analysis, through feasibility studies to full-scale project development. To help fuel the green economy and create green jobs, Greenstat owns and operates green hydrogen facilities, alone or in partnership with other stakeholders. We actively seek investments that are supported by targeted public expenditure, policy reforms and regulation changes to create the “enabling conditions” for an inclusive green economy. Our strategy aims to accelerate all progress towards a green economy.

The Greenstat Group have a strong and increasing focus on the international hydrogen market and on the Indian market. We are well positioned in India through strategic partnership and MOUs with several Indian companies and regions.

The idea of cooperation is central to achieving good results. The same applies to the use of existing networks and clusters to gain access to world-leading expertise. Greenstat is leading the Norwegian H2 cluster India, consisting of all the major players on the Norwegian H2 scene.

Centre of Excellence in Process Safety and Risk Management for a Hydrogen Economy (CoE in PS & RM – H²) Indian Institute of Technology, Delhi (IITD).



A unique Centre of Excellence in Process Safety & Risk Management for a Hydrogen Economy has been established in IITD, under a MoU between IITD (the Academic partner), Nayara (industry partner) and Gexcon (knowledge partner) to develop human capital and to carry out training, research, consultancy and advisory in domain areas of Process Safety, Risk management, Hydrogen Safety and Green Hydrogen, as also providing consultancy and advisory to industries, Govt. and Public Sector units of Govt.

This was the outcome of a series of meetings and discussions with Govt Ministries like MoEF, premium academic institutes like IIT Delhi, IIT Mumbai, IIT Dehradun, ICT Mumbai, and research Institutes like CSIR NEERI Nagpur, ONGC Safety Institute Goa, and leading process industries. Process industries in various sectors- Chemicals, petrochemicals, and energy like Oil & Natural Gas Corporation Limited recognize Process Safety & Risk Management as an area with an enormous potential.

There was unanimous agreement on the strong need for such a CoE in India. Further, all the participants exhibited keen interest to join hands to set up the CoE.

Accidents /disasters result in unacceptable loss of lives, injuries to people, loss of property, and damage to the environment. Moreover, they result in loss of reputation within the industry and loss of confidence among the public. They consume resources which otherwise can be deployed for development. Accidents over the past few decades, both within and outside the country, have raised awareness of the key risk control systems needed to prevent such accidents and have led to tighter regulations.

Brief Description on the idea of project:



Left to Right; Prof. Chitra Rajagopal (Director, CoE), Dr. J. P. Gupta (Chairman, CoE), Miss. Jale Cairney (CEO-Consulting, Gexcon), Mr. Paul Taylor (CEO – Software, Gexcon)

Emerging economies like India need to enhance their institutions and their infrastructure significantly and focus on prevention of accidents if they are to realise their long-term growth potential. Currently, there is no centralized system in India to document and investigate all chemical accidents. Globally it is proven that the learning from previous accidents helps in prevention of accidents and in designing safer plants and effective mitigation systems. Government, industry, and educational institutes work together on learning and prevention of accidents. Several Universities /research organizations have taken the initiative to develop advanced education and research in prevention of accidents.

Long term goal is replacing fossil fuels as an energy source with green power is becoming one of the most effective tools to combat climate change. Hydrogen is at the forefront of India's renewable energy roadmap to meet the country's commitments in COP26. Technological challenges related to all aspects of the Hydrogen economy (Production, Storage, Transportation and Utilization) need to be addressed. Most importantly, safety issues must be addressed for successful hydrogen technology acceptance and its deployment. A significant accident involving a hydrogen project could negatively impact the public's perception of hydrogen systems as viable, safe, and clean alternatives to conventional energy systems. However, insufficient knowledge about critical safety aspects related to the widespread roll-out of hydrogen technology represents a bottleneck for industry, authorities, end-users, and the public.

India already has a vast network of National Research Laboratories and premium academic institutions like IITs, NIT, and Universities which cover a wide spectrum of science and technology in the related to the Hydrogen ecosystem. However, India do not have any centralized centre or organisation which focuses on Hydrogen Safety and its future challenges. The commercial safe use of hydrogen needs co-ordination among the ministries and its regulatory bodies. To address the hydrogen technologies and its safety challenges we saw a need for the setting up of a Centre of Excellence (CoE) in Hydrogen by energy companies in India.

Under the guidance of several eminent scientists, professors, and subject matter experts, it was proposed to establish a Centre of Excellence (CoE) focusing on Process Safety and Risk Management for a Hydrogen Economy (CoE in PS & RM – H₂).

The purpose of this CoE is to enhance safety consciousness in the country and build capacity across all stakeholders in Industry, Govt., academia, and research Institutions, to ensure a better understanding of the concepts and practice of accident prevention and mitigation, as also, to enhance competence in and provide inputs for the development of safety standards and regulations. Eventually, CoE, PS & RM – H₂ will encourage innovation and R&D to develop indigenous solutions to build safer plants, develop better operating & maintenance practices and reduce overall risk to people, assets, and the environment.

It is the first of its kind in India, involved in training, higher education, research, developing innovative solutions and consultancy work. Selected candidates will also have the opportunity to enroll for Masters/ Ph. D from Global Universities under students exchange program

CoE PS & RM – H₂ is looking forward to expanding its support to industries like chemical process industries, petrochemicals, energy (renewable, oil & gas, Hydrogen, LNG), pharma, food & beverages, transportation, mechanical equipment for safety assessment and risk management.

Presently, CoE PS & RM – H₂ is equipped with the advanced computational facility and softwares offering a wide variety of analytical solutions to help understand and manage your challenges. These include tools in consequence modelling, quantitative risk analysis (QRA) and pre-incident planning.

With advances facility and process safety consultants, industry experts, and scientists will provide services to assist at all stages of your engineering and management control process, from concept design, process development, facility safe operation, initial hazard evaluation to continued safe operability of your facility.

CoE is also focused on to provide dedicated degree programs in the field of process safety and risk management and promote further R&D activities to meet the goal of Zero-Carbon emission 2050.

CoE Activity and Training Programs:



Visit of Gexcon Executive Leaders and CoE Governing Council at Shriram Institute, New Delhi.



Visit and Meeting of Gexcon Executive Leaders and CoE Governing Council on CoE Road Map at IITD CoE New Delhi.



One Day training program on Process Safety Management and Risk Management for Various Indian Government Research lab (DRDO, HEMRL, ARDE, NCL, ACEM), Conducted by Gexcon and CoE Experts at DRDO, Pune, India.



One Day training program on Process Safety Management and Risk Management for Insurance and Risk Management Industries, Conducted by Gexcon and CoE Experts at at National Insurance Academy (NIA), Pune.

UPL Center of Excellence in Process Safety at Shroff S. R. Rotary Institute of Chemical Technology



Left to Right; Mr. Vikram Shroff, Director at UPL Ltd., H.E. Nils Ragnar Kamsvåg, Ambassador of Norway to India and Mr. Sturle Pedersen, Global CEO & president of Gexcon

In 2019, UPL announced entering into a Memorandum of Understanding (MOU) with Gexcon AS, Norway, to progress its focus on Innovation Management in Process Safety, enabling UPL to strengthen the existing standards on Process Safety across its manufacturing facilities and projects worldwide. The MOU will build on the long-standing relationship between UPL and Gexcon AS to advance an operational excellence journey resulting in global leadership in the implementation of Process Safety & Risk Management.

The focus on Innovation in Process Safety & Risk Management will transform UPL's ability to develop new high-performance standards in line with global leaders in manufacturing hazardous chemicals. The capability to develop and implement these standards will help UPL to reduce the risks from their operations to Environment, Personnel & Assets. The goals of the Innovations in Process Safety Management focus will be to bring a cultural change among employees at all levels and improve the company's standards by operating in a cost-effective and sustainable manner.

UPL's aspiration is to achieve Global Leadership in the implementation of Process Safety and Risk Management and work on Research and Development areas by developing a 'Centre of Excellence' (COE).

The MOU involves the use of Gexcon technology in Process Safety and Risk Management for UPL plants worldwide as well as in setting up a 'Centre of Excellence' in 'Process Safety and Risk Management' for Pesticides and Toxic Chemicals at Gujarat (India)

Brief Description on the idea of project:



Left to Right; Mr. Ashok Panjwani, Chairman UPL University, Gujrat., Prof. Dr. Jan Roar Bakke Executive Vice President, Gexcon As.

The Center of Excellence (CoE) in industrial safety is established at Shroff S. R. Rotary Institute of Chemical Technology (SRICT) Ankleshwar, by the congruous collaboration of UPL Ltd. and Gexcon, Norway. Gexcon is a world-leading company in the field of safety and risk management, especially in the areas of advanced ventilation, dispersion, fire, and explosion modeling. Under the CoE, Gexcon AS will support and coordinate with University of Bergen in Norway and develop higher education and research programs in Safety in India. This will open a new domain constituting trained experts in risk assessment and performing consequence analysis using advanced techniques, in the field of process safety.

The CoE is bracing up to accept challenges for making industrial work field a safer place, protecting human lives, environment and properties. Zero accident in industries is a reachable target when attitude of caring meets sharing of relevant knowledge. CoE has an aim of not only

sharing the occurrences of industrial catastrophes, which fill us with fear and tears but would more like to help industries to focusing care for peers and pare their perils, being a seminal stakeholder of the society.

The main Objective of this centre is to:

- Enhance safety expertise at industrial working sites.
- Reduce these accidents by providing start to finish technical safety solution under single center.
- Assisting industries in implementation of Process Safety Management.
- Maintaining data base of accidents with analysis for learning and implantation.
- High Value Learning Audits of accidents and recommendations
- Development of Virtual Reality (VR)/ Augmented Reality (AR) training programs
- Various academic programs in Process safety
- Research and Development in Process Safety
- Certification courses at different levels.
- Increase awareness in all workers in the industries.

Salient Features of the COE

- First Center of Excellence (CoE) in process safety and risk management in the country.
- First Center of Excellence (CoE) in the field of safety to provide 3D CFD consequence analysis and quantitative risk assessment.
- First in India to have developed Accident Reporting System in Collaboration with DISH (Director Industrial safety and health)
- First CoE to provide the total safety solution model under single hood.
- “SAFEXCELLENCE” the Bimonthly e-News Letter for making awareness in process safety in the industrial and educational society.
- Training programs through advanced tools like Virtual/Augmented Reality (VR)
- First CoE in India to provide Safety training to all levels of professionals and Students.
- Process Safety Management Training Program to the professionals, faculty and students.
- CoE Members are certified and trained by GEXCON in FLACS Foundation Certification Course.
- MoU Signed Between DISH, Government of Gujarat and UPL CoE on 16th December 2020 for creating online accident reporting system.
- Under the aegis of CoE more than two thousand professionals and young engineering were trained for process safety through different certification courses.
- We have an advisory board suggest strategies of training according to which we have started creating awareness on safety practices among college and school students.

ORGANIZERS



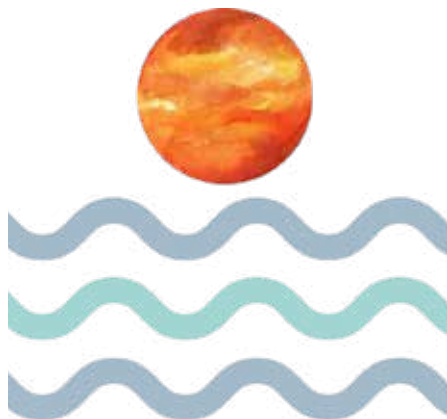
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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA

SUMMIT SPEAKERS





Alok Sharma
Executive Director,
Centre for High Technology



Alok B. Shriram
Former President
PHDCCI



Amit Verma
Director, Niti Aayog



Bård Vegar Solhjell
CEO
Norad



Benedicte Brinchmann
Partner, Eie Corporate
Communications



Bernhard Kvaal
Project Development Director,
TrønderEnergi



Bernt Skeie
CEO, Alma Clean Power &
Chairman Greenstat ASA



Bjørn Ottar Elseth
Director,
Arena H2Cluster



Dr. Chitra Rajagopal
Director, Centre of Excellence
for Process Safety and Risk
Management



Daniel Ras-Vidal
CEO,
Kjeller Innovation



Erik Solheim
Chairman of the Green
Hydrogen Development Plan
(GHDP), The Green Hydrogen
Organisation



**Ingebjørg Telnes
Wilhelmsen**
Secretary General, Norwegian
Hydrogen Forum



Jan Christian Vestre
CEO
Gexcon



Dr J P Gupta
Chair-Environment
Committee, PHDCCI



Dr. Karen Landmark
CSO, Greenstat



Kikki Kleiven
Director,
The Bjerknes Centre



Dr. Kjetil Midtun
CEO
Greensight



Lars Jacob Engelsen
Chief Operating Officer,
Norled



Leanne Drøyer
CEO
Greenstation



Mahendra Rustagi
Co-Chair
PHDCCI Environment



Parul Soni
Global Managing Partner,
ThinkThrough Consulting



P. Kumar
Chief Controller of
Explosives, PESO



Ragnhild Stokholm
Sustainability Manager, Aker
Clean Hydrogen



Rajnish Kumar
Former Chairman
SBI



Rina Sunder
Board Member,
The Modern India



Prof. S Dasappa
Chairman,
Indian Institute of Science



Siddharth R. Mayur
CEO,
h2e Power Systems



Siri Kalvig
CEO
Nysø Climate investments AS



Dr. SSV Ramakumar
R&D Director, Board Member,
Indian Oil Corporation Ltd



Ståle Gjersvold
CEO
TrønderEnergi



Steffen Møller Holst
VP Marketing, Sintef



Sturle Pedersen
Chairman, HomiHydrogen
& Greenstat Hydrogen India
Pvt Ltd



Sunil Jain
Operating Partner
Essar Capital



Dr. Sunita Satyapal
Director, US DoE



Tellef Thorleifsson
CEO, Norfund



Vegard Frihammer
CEO
Greenstat

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प्रौद्योगिकी विकास बोर्ड
TECHNOLOGY DEVELOPMENT BOARD
DEPARTMENT OF SCIENCE & TECHNOLOGY

OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA



SUMMIT PROGRAMME





International Climate Summit 2022 - Opportunities for Green Hydrogen in India

30th August 2022 - Day 1

moderator: Ms. Benedicte Brinchmann Eie, Partner, Corporate Communications AS

START	STOP	PROGRAM
09.00	09.30	Technical/registration
09.30	09.50	<p>Introduction/ Welcome by:</p> <ul style="list-style-type: none"> • Main moderator: Benedicte Brinchmann (Partner, Eie Corporate CommunicationsAS) • Mr Bernt Skeie (CEO, Alma Clean Power) • Mr Vegard Frihammer (GEO Greenstat ASA) • Mr Sturle Pedersen (Chairman, Greenstat Greenstat Hydrogen India) • Dr JP Gupta (Summit Chair & Chair, Environment Committee, PHDCCI) • Mr Alok Shriram (CMD, DCM Shriram Ltd, Leader of ICS 2022 Delegation and Former President, PHDCCI) • Ms Ingebjørg Tellnes Wilhelmsen (Secretary General, Norwegian Hydrogen Forum) • Mr Bjørn Ottar Elseth (Director, Arena H2Cluster) • Ms Rina Sunder (Det Moderne India)
09.50	12.00	Part 1: INAGURAL SESSION
		<p>Norwegian opportunities to India Jan Christian Vestre, Minister of Trade and Industry , Norway Espen Barth Eide, Minister of Climate and Environment, Norway</p>
		<p>Indian opportunities to Norway and the international society ministers, India (tbc)</p>
		<p>Climate actions, and energy transition - about connection with nature Gurudev Sri Sri Ravi Shankar</p>

Contd/-



International Climate Summit 2022 - Opportunities for Green Hydrogen in India

30th August 2022 - Day 1

START	STOP	PROGRAM
		Dr. B. Bala Bhaskar, Ambassador of the Republic of India to the Kingdom of Norway(tbc)
		Mukesh Ambani (or Hital R. Meswani), CEO, Reliance (tbc)
		Dr. SSV Ramakumar Director (R&D) and Board Member, IndianOil Corporation
		NN (tbc), title, Oil and Natural Gas Corporation Ltd (ONGC)
		Sustainability, society and energy transformation Kikki Kleiven, director Bjerknes senteret
		Dr Vijay Kumar Saraswat, Member (S&T), NITI Aayog-Government of India (tbc)
12.00	12.20	BREAK (COMMERCIAL AD)
		How to power the energy transition, with hydrogen - Erik Solheim, DMI
		Sh. Alok Sharma, Executive Director at Centre for High Technology (CHT) and Treasurer of Hydrogen Association of India
		Renewable energy investments a driver for development Bård Vegar Solhjell, CEO, NORAD
		Alexandra Bech Gjørsv, SINTEF (tbc)
		Kristian Røkke, CEO, Aker Horizons (tbc)
		Christian Rynning-Tønnesen, CEO/President, Statkraft (tbc)
		TrønderEnergis - outlook renewable energies in the nordics Ståle Gjersvold, CEO, TrønderEnergi

START	STOP	PROGRAM
12.00	13.00	LUNCH COMMERCIAL BREAK:
13.00	13.50	PART 2: GROUNDBREAKING PROJECTS FOR SCALING THE H2 VALUECHAIN
		Re-establishing large scale hydrogen production in Norway Vegard Frihammer, CEO, Greenstat
		Europe realising large scale green hydrogen production Steffen Møller Holst, Vice President Marketing, Hydrogen Technologies, SINTEF
		Building Norway's first hydrogen ferry Lars Jacob Engelsen, COO , Norled
		Q&A from the audience
		Introduction of parallel speakers
13.50	14.10	BREAK (COMMERCIAL AD)
14.20	16.10	PART 3: PARALLEL SESSIONS
		PARALLEL SESSION A: INVESTMENTS - private and governmental opportunities <i>moderator: Mr. Rajnish Kumar, Chairman and Managing Director, SBI</i>
		Norway's role in the global green hydrogen transition Tellef Thorleifsson, CEO, NORFUND
		Energy for development Bård Vegar Solhjell, CEO, NORAD
		Sustainable and profitable: investments for climate NN (tbc), title, Nysnø
		Mr. Rajesh Kumar Pathak, Technology Development Board, Department of Science & Technology, Government of India (tbc)
		Q&A from the audience
		BREAK (COMMERCIAL AD)
		NN (tbc), title, Enova SF
		Responsible investment management Sunil Jail, Operating Partner, Essar Capital
		Business opportunities in the Green Transition Hanne Løvstad, HR Director, Pricewaterhouse Coopers
		NN, title, Ferd
		Q&A from the audience
15.00	16.30	BREAK (COMMERCIAL AD)

START	STOP	PROGRAM
		PARALLEL SESSION B: TECHNOLOGY - challenges to succeed scaling <i>moderator: Daniel Ras-Vidal, CEO, Kjeller Innovation AS (H2Cluster)</i>
		Indias Technology Readiness for Green hydrogen Mr. Amit Verma, Director (Energy), NITI Aayog
		Innovative hydrogen technologies Steffen Møller Holst, Vice President Marketing, Hydrogen Technologies, SINTEF
		How can India unlock its green hydrogen ambitions? Sturle Pedersen, Chairman, Greenstat Hydrogen India (HomiHydrogen)
		Mari Sundli Tveit, CEO, The Research Council of Norway (tbc)
		Q&A from the audience
		BREAK (COMMERCIAL AD)
		Electrolyser technologies - emerging and established Kjetil Midtun, CEO, Greensight
		Achieving zero emission deep sea shipping Bernt Skeie, CEO, Alma Clean Power
		Technologies for Clean, green, and secure energy Siddharth R. Mayur. Founder President & CEO, h2e Power Systems (HomiHydrogen)
		NN, CEO, PTC India (tbc)
		Q&A from the audience
15.00	16.30	BREAK (COMMERCIAL AD)
		PARALLEL SESSION C: SAFETY - guidelines and capacity-building <i>moderator: Dr. J.P. Gupta, Summit Chair & Chair, Environment Committee, PHDCCI)</i>
		Understading Hydrogen Safety Trygve Birkeli, CEO, Gexcon
		Elisabeth Askim, acting CEO, Directorate for Civil Protection and Emergency (tbc)
		Ingrid Dahl Hovland, CEO, The Norwegian Public Roads Admininstration (tbc)
		NN
		Q&A from the audience
		BREAK (COMMERCIAL AD)

START	STOP	PROGRAM
		Indias Path to Safe Hydrogen Production and Use Mr. P. Kumar –CCOE, PESO
		Make India Safer while Make in India Dr. Chitra Rajagopal, Director, COE in process safety & risk management
		Safety gaps: Codes and Standards Dr. Sunita Satyapal, Director, Hydrogen and Fuel Cell Technologies Office, and DOE Hydrogen Program Coordinator, U.S. Department of Energy
		Q&A from the audience
15.00	16.30	BREAK (COMMERCIAL AD)
		PARALLEL SESSION D: DECARBONIZATION - governmental impact <i>moderator: Dr. Karen Landmark, Chief Strategy Officer Greenstat and Chair Greenstat Asia</i>
		Knut Nyborg, CEO, Aker Clean Hydrogen (tbc)
		Value chain emissions - true net zero Prof. S Dasappa, Chair, Interdisciplinary Centre for Energy Research, Professor, Centre for Sustainable Technologies, Indian Institute of Science Bangalore
		Q&A from the audience
		BREAK (COMMERCIAL AD)
		How blue hydrogen can play a part in the energy transition Egil Rensvik, PM, NORWEP
		ESG -A tool for Decarbonisation Mr Mahendra Rustagi, Co-Chair of the Environment Committee of PHDCCI, and CEO of Kreston SNR Advisors
		Decarbonizing Indias transport sector Sh. Alok Sharma, Executive Director at Centre for High Technology (CHT) and Treasurer of Hydrogen Association of India
		Q&A from the audience
15.00	16.30	BREAK (COMMERCIAL AD)

START	STOP	PROGRAM
		<p align="center">PARALLEL SESSION E: END USERS</p> <p align="center"><i>- Hydrogen opportunities in the energy system moderator: Ms Rina Sunder, CEO, Det Moderne India</i></p>
		<p>Responsible consumers and industry - generating market demand Parul Soni, Global Managing Partner at Thinkthrough Consulting</p>
		NN ((tbc), title, City of Oslo
		<p>Greener and better user experiences Leanne Drøyer, CEO, Greenstation</p>
		Vibeke Rasmussen (tbc), SVP Product Management & Certification, Yara
		Q&A from the audience
		BREAK (COMMERCIAL AD)
		<p>Being planet-positive: values beyond finance Ragnhild Stokholm, Sustainability Manager, Aker Clean Hydrogen</p>
		NN, title, Asko (tbc)
		<p>Creating tomorrows energ solutions Bernhard Kvaal, Project Director Development, TrønderEnergi</p>
		Q&A from the audience
15.00	16.30	BREAK (COMMERCIAL AD)
16.30	17.00	<p>PART 4: PANEL DEBATE</p> <p>OPPORTUNITIES ON GREEN HYDROGEN IN INDIA</p>
16.33	17.00	Selected group of speakers from summit - TO BE DECIDED:
17.00	17.10	THE END



International Climate Summit 2022 - Opportunities for Green Hydrogen in India

31st August 2022 - Day 2

START	STOP	PROGRAM
12:30	01:30	Bergen City Center-> Kollsnes, by Electric Buses or- Cars
02:00	03:30	Kollsnes, Øygarden Municipality: Northern Lights- CCS/ ZEG Power- H2 production/ CCB Kollsnes
03:30	04:30	Lunch, organised by the Mayor of Øygarden Municipality, Tom Georg Indrevik
04:30	6:30	Kollsnes-> Fantoft, with possible stop on the way (or passing by): Greenstation (energystation at Straume)/ Uno-X hydrogen station at Asane/ Green Yacht/ Others
06:30	8:30	Fantoft- Business presentations and venture lab: Alma Clean Power/ Clara Venture LabsGreen- stat/ Gexcon/ Norled?/ LMG Marine/ Corvus Energy/ Others
	8:30	Return to Bergen, City Center

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OPPORTUNITIES FOR GREEN HYDROGEN IN INDIA



SPONSORSHIPS AND SUPPORT PARTNERS





About DCM Shriram Industries Limited (DSIL)

A. DCM SHRIRAM INDUSTRIES LIMITED a public limited listed company was incorporated in 1989 under the Indian Companies Act, 1956. The Company's Registered office is at Kanchenjunga Building, 18 Barakhamba Road, New Delhi – 110001 (www.dcmsr.com).

In the year 1990 DCM Limited, a conglomerate comprising of 12 manufacturing units, in diverse areas, which had a legacy of over 100 years, was restructured into four companies by a Scheme of Arrangement approved by the Delhi High Court. DCM Shriram Industries Limited was one of the four companies, in which 3 of the manufacturing units of DCM Limited, viz Daurala Sugar Works (comprising of sugar, chemicals and alcohol), Shriram Rayons (engaged in manufacture and marketing of industrial fibres) and Hindon River Mills (engaged in textile business since divested).

The Company is presently engaged in the business of manufacturing and marketing of Sugar, Alcohol, Potable Alcohol, Co-generation of Power, Industrial Fibres and Chemicals. The group has since diversified in Engineering and Defence products.

B. SHRIRAM INSTITUTE FOR INDUSTRIAL RESEARCH (SRI) is an independent, self sustaining, not-for-profit multidisciplinary contract research institute conducting research and development in the areas of special significance to industry, government agencies and other organizations. SRI is committed to develop, innovate, analyse and apply technology for products and processes. (www.shriraminstitute.org).

SRI also brings its innovations to the marketplace by licensing its technologies and helps in establishing production units for the interested clients.

SRI, founded in 1947 by Sir Shriram, started functioning in 1950. Sir Shriram believed that if India was to catch up with the rest of the world, it was necessary to understand existing technology and innovate it through research.

SRI's strengths have been its staff backed by a knowledgeable, expert and experienced Governing Board and an innovative management. SRI is operational from its Delhi and Bangalore campuses. SRI's thrust areas are Materials Science, Analytical Science, Life Science, Irradiation of Medical and Surgical products and Quality Assurance.

Recent research areas are in Material Science includes Blood bags, Cactus Latex based products, Biomaterials, Materials for Aero Space Applications, Polymers for Electronics, Hightech Adhesives, Polymers, Composites, Specialty Chemicals, Renewable resources, Radiation based Technologies, Herbal Products, Waste Utilization, Technical Consultancy etc.

The Analytical Sciences Division provides prompt, precise and dependable analytical services in the fields of metal and minerals, rubber and plastics, building materials, paper, leather and textiles, chemicals and agro chemicals, food and pharmaceuticals, petroleum products, home appliances and Microbiological studies. The Division standardises, develops and validate new methods for analysis. It provides assistance to customers to ensure the quality of products laid down by various certifying agencies and statutory bodies. It also provides Calibration services.

SRI's Life Sciences Division conducts research on various aspects of Environment including Biological Impact Studies, Rapid Environmental Impact Studies and Comprehensive Environmental Impact Studies. The Division undertakes toxicological studies to establish safety levels of chemicals, agrochemicals and herbal products, a must for environment protection, safety and health care.

Shriram Applied Radiation Centre, SARC, established with the technical assistance of BARC, conducts research in polymer modifications and undertakes irradiation of life saving medical and surgical products and spices.



Alok B. Shriram

**Senior Managing
Director & CEO**

He is closely associated with Industry and Trade Associations and is Former President of PHD Chamber of Commerce and Industry (PHDCCI), an apex body of trade & industry in India. He continues to be associated with PHDCCI and also is on the Executive Committee of Federation of Indian Chambers of Commerce and Industry (FICCI). He is Vice President of All India Organisation of Employers' (AIOE). He is also closely associated with Indian Sugar Mills Association, CII, AIMA etc. He is a life member of the Textile Association of India.



About Reliance Industries Limited (RIL)

Reliance Industries Limited is a Fortune 500 company and the largest private sector corporation in India.

Our motto “Growth is Life” aptly captures the ever-evolving spirit of Reliance. We have evolved from being a textiles and polyester company to an integrated player across energy, materials, retail, entertainment and digital services. In each of these areas, we are committed to innovation-led, exponential growth. Our vision has pushed us to achieve global leadership in many of our businesses.

Reliance's products and services portfolio touches almost all Indians on a daily basis, across economic and social spectrums. We are now focussed on building platforms that will herald the Fourth Industrial Revolution and will create opportunities and avenues for India and all its citizens to realise their true potential.



**Mukesh Dhirubhai
Ambani**

**Chairman & Managing
Director**



HINDUSTAN ZINC

Zinc & Silver of India

About Hindustan Zinc Limited

Hindustan Zinc, a Vedanta Group Company, is one of the world's largest and India's only integrated producer of Zinc-Lead and Silver. The Company has its Headquarter at Udaipur in the State of Rajasthan where it has its Zinc-Lead mines and smelting complexes.



Arun Misra

Chief Executive Officer



About UPL Ltd.

UPL Ltd. is a global provider of sustainable agriculture products & solutions, with annual revenue exceeding \$5 billion. We are a purpose-led company. Through OpenAg, UPL is focused on facilitating progress for the entire agricultural value chain.



Jai Shroff

Group Chief Executive
Officer



Veritas Polychem Pvt Ltd

About Veritas Polychem Private Limited (VPPL)

VPPL is wholly owned subsidiary of Veritas (India) Limited a listed Indian company, part of Groupe Veritas (GV) promoted by a young entrepreneur. Groupe Veritas with its worldwide presence, is focused on International Trade & Distribution, Infrastructure & Logistics and Alternate Fuel & Energy - Wind Turbines and Solar Panels.



Nitin Kumar Didwania

Managing Director



GAIL (India) Limited

About GAIL (India) Limited

GAIL (India) Limited is India's largest natural gas company having a market share of over 75% in natural gas transmission. GAIL possesses over 13,389 km of natural gas pipeline transmission network with a capacity of 204 MMSCMD.



Manoj Jain

Managing Director



About Nayara Energy

Nayara Energy is a downstream energy and petrochemicals company of international scale with strong presence across the hydrocarbon value chain from refining to retail. Nayara Energy's fuel retail network consists of 6000+ outlets across India and is the fastest growing private retailer in the energy sector.



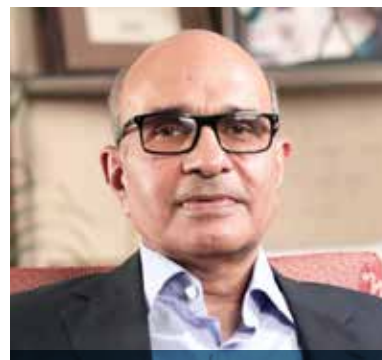
Dr. Alois Virag

Chief Executive Officer



About Sheela Foam Limited

Sheela Foam Limited ("Sheela Foam" or the "Company") established in 1971, listed on Bombay Stock (BSE) and National Stock Exchange(NSE), manufactures mattresses, other foam-based home comfort products and technical grades of PU Foam. The company has a global manufacturing footprint with 11 nationwide manufacturing plants in India, 5 in Australia, and 1 in Spain. The company has an integrated manufacturing facility 123,000 MTPA with a robust distribution network of 110+ exclusive distributors, 5,400+ exclusive retail dealers, and 6,100+ multi-brand outlets. The Company is also exporting technical foam to Middle East, South Asia, Europe, United States, Brazil, and Argentina etc.



Rahul Gautam

Managing Director



About Epsilon Carbon

Established in 2010, Epsilon Carbon, India's first integrated coal chemicals complex which is strategically located near raw material sources, our core advantage is 100% captive input materials. Epsilon Carbon has always partnered as important part of supply chain for many of India's biggest names in aluminium, carbon black, tyres and mechanical rubber goods, & other specialty chemicals.



Vikram Handa

Managing Director



About CDET Explosive Industries Private Limited

CDET Explosive Industries Private Limited is a leading manufacturer and exporter of Explosive Initiation Systems and Packaged Explosives, located in Central India. Founded by Mr. Ashok Vithaldas Rathi in 1998, CDET has grown to be a trusted and recognized provider of blasting solutions for the mining industry.



Ashok Vithaldas Rathi

Managing Director



DEEPAK FERTILISERS
AND PETROCHEMICALS
CORPORATION LIMITED

About Deepak Fertilisers and Petrochemicals Corporation Limited

Founded in 1979, Deepak Fertilisers and Petrochemicals Corporation Limited (DFPCL) is India's leading producer of Fertilisers and Industrial Chemicals. Since its inception, DFPCL has leveraged the power of science and innovation to enable not only its customer base, but also the nation, to progress substantially.



S C Mehta

Chairman and Managing
Director



About Indian Oil Corporation Ltd

As India's flagship national oil company in the downstream petroleum sector, IndianOil has been fuelling the energy demands of India for over five decades. With a 33,000-plus work-force, extensive refining, distribution & marketing infrastructure and advanced R & D facilities Indian Oil plays a significant role in fuelling the socio economic development of the country



**Shrikant Madhav
Vaidya**

Chairman



About Oil and Natural Gas Corporation Ltd.

Maharatna ONGC is the largest producer of crude oil and natural gas in India, contributing around 70 per cent of Indian domestic production. The crude oil is the raw material used by downstream companies like IOC, BPCL, HPCL to produce petroleum products like Petrol, Diesel, Kerosene, Naphtha, Cooking Gas-LPG.



Dr. Alka Mittal

Chairman and Managing
Director



About GE

GE rises to the challenge of building a world that works. For more than 126 years, GE has invented the future of industry, and today the company's dedicated team, leading technology, and global reach and capabilities help the world work more efficiently, reliably, and safely. GE's people are diverse and dedicated, operating with the highest level of integrity and focus to fulfill GE's mission and deliver for its customers.



Deepesh Nanda

CEO, GE Gas Power
South Asia



About HPCL-Mittal Energy Limited (H MEL)

HPCL-Mittal Energy Limited (H MEL) is a joint venture between Hindustan Petroleum Corporation Limited (HPCL) and Mittal Energy Investment Pte Ltd, Singapore, a Lakshmi N Mittal Company. H MEL owns and operates the Guru Gobind Singh Refinery (GGSR) of 11.3 MMTPA capacity at Bathinda, Punjab. H MEL's wholly owned subsidiary, HPCL-Mittal Pipelines Limited (HMPL), owns and operates a Single Point Mooring (SPM), Crude Oil Terminal (COT) and 1017 km cross country pipeline for transportation of the crude from Mundra, Gujarat to the refinery at Bathinda.



Prabh Das

Managing Director &
Chief Executive Officer



About MRN Group

The MRN Group was established in 1995 with the headquarters at Mudhol and Corporate offices in Bangalore, India. The primary aim of the group is to create an environment of growth, sustainability, fair business practices, and propel India towards a future of just industrialisation, while ensuring a reduction in our carbon footprint.

The MRN Group consists of 21 companies with interests and divisions in sugar production, ethanol, renewable energy, banking, cement, LNG, CNG, retail, education, fertilisers, agro related products, CO₂, textiles, construction and the social welfare organisation, The MRN Foundation. With varied and impactful companies under their conglomerate, the MRN Group has been a key driving force to secure industrial development and growth with sustainability, integrity and sound business ethics being the primary factors.



Vijay M. Nirani

Managing Director



About ACME Group

The ACME Group is one of the India's fastest growing companies in solar energy sector. ACME provides innovative green energy and energy management solutions for Telecom Passive Infrastructure and is one of the largest Solar Power developer with cumulative capacity of more than 5500+ MWp Solar Photovoltaic Power Projects across the country.



Manoj K Upadhyay

Founder & Chairman



Phillips Carbon Black Limited

About Phillips Carbon Black Limited

Phillips Carbon Black Limited (PCBL), a part of RP-Sanjiv Goenka Group, was set up by Mr. K. P. Goenka in 1960, with the core objective of substitution of the import of carbon black. The company started production at Durgapur with a production capacity of 14,000 MT per annum. As PCBL celebrated its diamond jubilee in 2020, it has been playing a pioneering role in the carbon black industry for over six decades, with a current production capacity of 6,03,000 MT per annum and generating 84 MW per hour of green power. Today, PCBL is the largest carbon black manufacturer in India and a strong global player with a significant customer base in 40+ countries.



Sanjiv Goenka

Chairman



About Engineers India Ltd

EIL, a Navratna PSU, is one of the leading design and engineering organizations in South Asia. Established in 1965, EIL provides engineering consultancy and EPC services principally focused on the oil & gas and petrochemical industries. The Company has also diversified into sectors like Infrastructure, Water and Waste Management, Solar & Nuclear Power and Fertilizers to leverage its strong technical competencies and track record.



Vertika Shukla

**Chairperson &
Managing Director**



About Nichino India Pvt. Ltd.

Since its inception in 1928, it has been building on its accumulated research and development activities as Japan's first manufacturer of agrochemicals, as well as its well-earned position of trust, NNC-Nichino has extended its operations beyond the shores of Japan to actively enter overseas markets, particularly in India adopting Make in India policy.



Hideji Hosoda

**Chairman & Managing
Director**



About Bharat Oman Refineries Limited

Bharat Oman Refineries Limited was incorporated in 1994 as a Public Limited Company with equal equity participation of Bharat Petroleum Corporation Limited ("BPCL", a Government of India Undertaking) and OQ (formerly OOC). Presently, BPCL is holding 63.4% and OQ is holding 36.6% equity in the Company. The company has become subsidiary of BPCL effective from 1st April, 2020. The Government of Madhya Pradesh is also stakeholder in the Company.



K. Padmakar

Chairman



About Kent RO Systems Limited

Kent RO Systems Limited is a 21st century health care products company with a vision for making the world a healthy and a happy family. It provides innovative health care products that purify the water we drink, the food we eat and the air we breathe, thus help people live healthier.



Dr. Mahesh Gupta

Managing Director



About Meghmani Organics Limited

Meghmani Organics Limited established in the year 1986 is a leading diversified Chemical Company poised for growth across its three (Pigment, Agrochemicals and Chlor-Alkali and Derivatives) high potential businesses. MOL is among top 3 Pigment manufacturers globally with 14% global market share in Phthalocyanine Pigments, among top 10 vertically integrated Agrochemical players in India having products across entire value chain.



Ankit Patel

Chief Executive Officer



About Action TESA

Balaji Action Buildwell laid its manufacturing for MDF/HDHMR & Particle Board and their allied value added products namely Pre-laminated Particle Board, MDF, & HDHMR, HDF Laminate Wooden Flooring, Embossed HDF, UV Coated Panel, Acrylic Hi Gloss Boards, HDHMR Doors under the brand name Action TESA.



Vivek Jain

Managing Director



About Nirma Ltd.

Nirma Group, today, is a Multi-product, Multi-location Conglomerate with revenues in excess of USD 1.20 billion and presence in Consumer Products, Chemicals, Cement, Healthcare, Packaging, Real Estate, Agro Products, Fertilizers, Castor Oil and Mining - with exports to more than 50 countries across 6 continents from its plants at more than 10 locations in India, MENA and North America. The one-man entity has now grown to more than an 25000 strong dedicated team.



Hirenkhai K Patel

Managing Director



About Aarti Industries Limited (AIL)

AIL is a leading Indian manufacturer of specialty chemicals and pharmaceuticals with a global footprint. It combines process chemistry competence (recipe focus) with a scale-up engineering competence (asset utilization) for creating a sustainable future. AIL manufactures chemicals used in the downstream manufacturing of pharmaceuticals, agrochemicals, polymers, additives, surfactants, pigments and dyes. The company globally ranks 1st – 4th position for 75% of its portfolio – and is a 'partner of choice' for various major global and domestic customers. AIL has a de-risked portfolio that is multi-product, multi-geography, multi-customer and multi-industry. Over the past 3 decades, AIL has emerged as a Global Partner of choice with 250 + products for over 400+ Global and 700+ domestic customers across the globe in 60 countries with a major presence in the USA, Europe, Japan, China, and India.



Chandrakant V. Gogri

Chairman

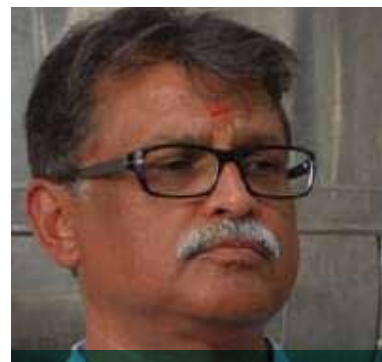


KELTECH ENERGIES LTD

A VISION FOR CONSERVATION

About Keltech Energies Limited

KEL was incorporated in the year 1977 by the Chowgule Group a flagship companies, Goa. KEL is an listed company and is in the manufacture of industrial explosives. The Company has manufacturing units at Vishwasnagar, Udupi Karnataka, Nagpur and Chandrapur (Maharashtra) with technological collaboration from DuPont Water-gel Technology.



Santosh Chowgule

Managing Director



About GSP Crop Science Pvt Ltd

GSP Crop Science Private Ltd Cultivate a sustainable legacy of safe and environment-friendly agricultural growth and work for farmers' well-being. As an Agro Chemicals Company in India, GSP manufactures advanced and Eco-friendly agrochemical products in India, pesticides and crop protection products with a vision to help farmers and consumer at large.



Vrajmohan R. Shah

Chairman



About Oil India Limited (OIL)

Oil India Limited (OIL) is a fully integrated Exploration & Production company in the upstream sector, with origin dating back to the glorious year (1889) of oil discovery in India. It is a state-owned enterprise of the Government of India, under the administrative control of the Ministry of Petroleum and Natural Gas.



Harish Madhav

Chairman



About Hindustan Oil Exploration Co. Ltd.

HOEC's story began in 1983, when the great visionary, the late Shri. H.T. Parekh, foresaw the need for private participation in the Indian Oil & Gas sector. After more than 3 decades of existence, HOEC has now emerged as a fast-growing and independent E&P player in India. HOEC now, through its operations contributes 10,000 boe of products everyday to the nation, from 4 of the 7 producing basins in India. We have turned around our fortunes by adopting a low-cost, fast-track development model with a focus on local content, innovation and sustainable practices. We aim to create long-term stakeholder value while ensuring that we 'Grow Responsibly'.



P Elangoi

Managing Director



About Hetero Labs

Hetero is one of India's leading generic pharmaceutical companies and the world's largest producer of anti-retroviral drugs. Backed by 25 years of expertise in the pharmaceutical industry, Hetero's strategic business areas spread across APIs, generics, biosimilars, custom pharmaceutical services and branded generics.



Dr. B. Partha Saradhi Reddy

Chairman and Managing Director



ANUPAM RASAYAN INDIA LTD.

About Anupam Rasayan India Limited

Anupam Rasayan India Limited is renowned group for in the custom synthesis and manufacturing of specialty chemicals in India since 1984. We have established strong relationship with some reputed customer for supply of life science related specialty chemicals comprising products related to agrochemicals, personal care and pharmaceuticals, and other specialty chemicals, comprising specialty pigment and dyes, and polymer additives.



Anand Desai

Managing Director



About Tagros Chemicals India Pvt. Ltd.

Tagros is today one of India's fast growing agrochemical companies. It's the subsidiary of the centenary celebrating business conglomerate – The Jhaver Group. It is the leading manufacturer of Synthetic Pyrethroids, Herbicides, Fungicides, Pesticide Intermediates and Special Formulations, producing 2,500 metric tons of active ingredients and exporting them to over 90 countries.



Parikshith Jhaver

Director



About Balrampur Chini Mills Limited

Balrampur Chini Mills Limited founded in 1975, is one of the largest sugar manufacturing company in India. It is one of the first sugar companies in the country to diversify its business from sugar to distillery and cogeneration. BCML has successfully created a wide range of co-products ranging from Molasses, Alcohol, Ethanol and Bagasse to Power Generation.



Vivek Saraogi

Chairman & Managing
Director



About Paradeep Phosphates Ltd .

Paradeep Phosphates Ltd (PPL) is a leading fertilizer company with an annual turnover close to Rs. 5, 500 crores. PPL is part of Adventz Group of Companies led by the group Chairman Mr Saroj Kumar Poddar. The government of India holds 19.55% of shares while 80.45 % shares are held by Zuari Maroc Phosphates Pvt Ltd, a joint venture between the Adventz group company, Zuari Agro Chemicals Ltd. and Maroc Phosphore S.A., a wholly owned subsidiary of OCP, Morocco. PPL's primary focus is the production and marketing of complex phosphatic fertilizers. PPL is committed to improving agricultural productivity and for the betterment of the farming community.



Saroj Kumar Poddar

Chairman & Non
Executive Director



Dalmia Bharat Sugar and Industries Limited (DBSIL)

Dalmia Bharat Sugar and Industries Limited (DBSIL) is a part of Dalmia Bharat Group which was founded in 1939. Having been around for more than 80 years, the group now enjoys leadership in core sectors such as Cement, Refractories and Sugar.



Bharat Bhusan Mehta

Whole Time Director &
CEO



About DCM Shriram Ltd.

DCM Shriram Ltd. is a leading business conglomerate with a group turnover of Rs. 8308 crores. The business portfolio of DCM Shriram comprises primarily of Agri-Rural Business, Chlor-Vinyl Business and Value added business (Fenesta Building Systems). DCM Shriram, a spin-off from trifurcation of the reputed erstwhile DCM Group in 1990.



Ajay S. Shriram

Chairman & Sr. Managing Director



About Jawahar Shetkari Sahakari Sakhar Karkhana Limited

JSK was established in 1990 under The Maharashtra Co-operative Society Act 1960. In 1994, its status was converted into a 'Multi-State Co-operative Society' by incorporating a total of 220 villages in its area of operations, including 80 villages in Karnataka and 140 villages in Maharashtra. JSK's sugar factory is located at Hupari Village in Kolhapur District, on the southern border of Maharashtra adjoining Karnataka. The first sugar season of the company was 1993-94 with a crushing capacity of 2,500 tonnes crushed per day (TCD) and a cogeneration capacity of 1.5 megawatt (MW). The crushing capacity was subsequently enhanced in stages, with the present installed capacity as of February 2020 standing at 12,000 TCD and bagasse-based cogeneration of 27 MW. In SY2018-19, JSK crushed 17.6 lakh MT of sugarcane to produce 2.2 lakh MT of sugar with an average recovery rate of 12.75%.



Kallappa Baburao Awade

Chairman



About Triveni Engineering & Industries Limited

The Company produces premium quality multi-grade crystal sugar, raw, refined and pharmaceutical sugar. All of the Sugar units are FSSC 22000 certified. It also has a strong presence in the branded sugar market through its brand "Shagun". The distillery at Muzaffarnagar produces Ethanol, Extra Neutral Alcohol (ENA), alcoholic beverages IMIL and Hand Sanitizers". The distillery at Sabitgarh produces Fuel-grade Ethanol.



Dhruv Sawhney

Chairman & Managing
Director



About Godavari Biorefineries Limited

Somaiya Group has been working in the field of Sugar Production & Agricultural Products Business since 1939. Godavari Biorefineries Limited is the Flagship Company of The Somaiya Group. The Company was further expanded by diversification into Chemicals and forward integration of Sugar Business to Cogeneration of Power and Alcohol Manufacturing.



Samir Somaiya

Chairman and Managing
Director



About Kadam Environmental Consultants (KEC)

Established in April 1981, Kadam Environmental Consultants (KEC) is one of the oldest and largest Environment, Health and Safety (EHS) consulting companies in India, providing comprehensive environmental solutions from concept to commissioning under one roof.



Sameer Kadam

Joint Managing Director



Sangram Kadam

Joint Managing Director



About Dalmia Services Export Promotion Council

SEPC is an Export Promotion Council set by Ministry of Commerce & Industry, Government of India. It is an apex trade body which facilitates service exporters of India. As an advisory body it actively contributes to the formulation of policies of Government of India and acts as an interface between the Services Industry and the Government.



Maneck E. Davar

Chairman



RANA SUGARS LIMITED

About Rana Sugars Limited

Rana Sugars Ltd. was founded in 1992 by collaboration with Punjab AgroCorporation. In year 2002 RSL has setup a Demonstration Co-generation Project to produce extra power from the Bagasse (by-product of sugar) and export it to Punjab State Electricity Board.



Rana Ranjit Singh

**Co-Founder & Chairman,
Rana Group**



**Indian Association for
Air Pollution Control**

About Indian Association for Air Pollution Control - Delhi

The Indian Association for Air Pollution Control was formed at B.H.U. Varanasi, India on 18th September 1976. The Association has been very active in promoting an understanding of the Air environment and of its pollution, its effects on human beings, animals, plants and materials and control of such pollution. It is an active and effective forum for exchange of views and information on the air quality and its conservation. Association publishes a technical journal titled “Indian Journal of Air Pollution Control” and recognises contribution of scientific professionals.

The Association has organised Conferences on some very important topics, which have contributed in development of standards on Ambient Air Quality standards in 2009, Air Pollution problems due to burning of Agricultural residues (2006), Evolving strategies for improving Air quality of Indian cities (2008) and Indoor Air Quality (2014). Association also organizes an annual event in the month of September in the memory of some Late eminent scientist.

This is a unique body of professionals in this field and is silently playing a very constructive role in the society. It has many eminent persons as its member. One of our president (Late) Prof. Delip Biswas received Padma Shree in 2007 in recognition of his out-standing contributions for Environment Protection. Currently, Association is headed by Dr. J. S. Sharma, President and eminent scientist with Vast experience in Environment.



Dr. J. S. Sharma

President



About KRESTON SNR

Kreston SNR head quartered at New Delhi is a member of “Kreston International” a Global Network of Independent Accounting Firms having presence in over 120 countries. Kreston SNR assists clients in the areas of Assurance & Risk Advisory, India Entry Support, Tax Advisory, Transaction & Business Advisory, Corporate & Allied Laws, Forensic Services, Renewable energy, Process safety and Management Consultancy and Outsourcing Services.



Mahendra Rustagi

CEO



About Hydrogenium Resources Pvt. Ltd.

Hydrogenium Resources Pvt Ltd, is an ethical independent advisory services company and projects developers providing innovating solutions with in the entire low carbon & green Hydrogen eco-system. It's been promoted by highly experienced sustainability focussed techno-commercial professionals with international network of innovating technology/ hydrogen / energy services companies, projects developers and cleantech investors.

Hydrogenium facilitates project owners and developers in the entire spectrum of project planning including technology sourcing, collaborations, project planning, innovating project financing solutions, investments with services till project development – all services from Ideation till Ready for Implementation.

As transformation agents and change leaders for Sustainability initiatives and Net Zero transition, Hydrogenium tends to create value by providing innovative solutions for the low carbon Hydrogen and Renewable Energy projects. Hydrogenium can play preeminent parts in all Sustainability and Net Zero transition initiatives.



Mr Umesh Sahdev

Executive Chairman,
Hydrogenium Resources
Pvt. Ltd



About *ITEN Media*

ITEN Media is India's flagship organiser of global industry forums & digital initiatives that amplify thought leadership, demand generation and customer engagement strategies for key industry sectors, 365-days a year. Our content led initiatives deliver valuable market insights, expert viewpoints and CXO level networking opportunities to world leading organisations; facilitating their business initiatives across the Indian sub-continent.

With decades of industry expertise & exceptional networking with Governments, Industry Bellwethers and global trade bodies, our audience include thousands of qualified buyers & decision makers from key sectors like Oil & Gas, Power & Utilities, Renewables, Green Hydrogen, Metals & Mining, Maritime, Infrastructure, Chemicals & Fertilizers, Aviation, Pharmaceuticals, Healthcare, Automotive, Safety & Environment Protection etc.



Abhishek Bhatnager

CEO & Director

Knowledge Partners





PHD CHAMBER OF COMMERCE AND INDUSTRY

About Us

PHD Chamber of Commerce & Industry, a leading Industry Chamber of India, ever since its inception in 1905, has been an active participant in the India Growth Story through its Advocacy Role for the Policy Makers and Regulators of the Country. Regular interactions, Seminars, Conference and Conclaves allow healthy and constructive discussions between the Government, Industry and International Agencies bringing out the Vitals for Growth. As a true representative of the Industry with a large membership base of 1,30,000 direct and indirect members, PHD Chamber has forged ahead leveraging its legacy with the Industry knowledge across sectors (58 Industry verticals being covered through Expert Committees), a deep understanding of the Economy at large and the populace at the micro level.

At the National level, the PHD Chamber is well represented in 16 States with its own offices and MOUs with eleven Partner Chambers in different States.

At the Global level we have been working with the Concerned Ministries, Embassies and High Commissions to bring in the International Best Practices and Business Opportunity.

PHD Chamber has special focus on the following thrust areas:

- | | |
|---------------------------------------|---------------------------------|
| • Economic & Business Policy Advocacy | • Education & Skill Development |
| • Industry | • Agriculture & Agri-business |
| • Infrastructure | • ICT |
| • Housing | • International Trade |
| • Health | • Defence & HLS |

PHD CHAMBER OF COMMERCE AND INDUSTRY

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