Quarterly Newsletter

# BIO-ऊर्जा

## Sardar Swaran Singh National Institute of Bio Energy, Kapurthala

(An Autonomous Institution of Ministry of New and Renewable Energy)

July 2023 Issue 3

# Word from Director General, SSS-NIBE

*The third issue of our quarterly newsletter is scheduled for release as we complete the first quarter of the new financial year 2023–24. In order to uncover intriguing technological findings before the end of the financial year, the first quarter was effectively used to plan and strategize the R&D work of all five divisions. There have been substantial efforts put up in finding right industrial partner for the piloting of CBG and 2G Ethanol technologies, we expect to seal a few agreements by the end of second quarter. Likewise, there has been no. of interactions with several industries, agencies on topics ranging from collaborative work to consultancy. One success I would like to highlight is the commencement of SAGE 2.0 activity between SSS NIBE and PNNL under USAID, which addresses two projects – biomass supply chain management and bio-$H_2$. Similarly, preparations have reached a crescendo with respect to hosting of international conference (ICRBAR) in October 2023. All staff and students are looking forward to this event. As it goes without saying, we appreciate your thoughts and recommendations to improve communication in the upcoming newsletter.*

***Dr. G. Sridhar***
***(Director General)***
***SSS-NIBE***

# Research and Innovation

## Algae the 3rd gen bioenergy feedstocks

Ever-escalating global energy demand and global warming due to the burning of fossil fuels encourage the necessity for exploring and implementing alternate clean, green, and sustainable energy resources. Among several other renewable energy alternatives, bioenergy production from algae has acquired wide recognition over the last few years. In addition, bioenergy derived from algae is considered one of the clean, green, and sustainable energy resources and can be integrated into the biorefinery process.

Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multi-cellular forms. Algae are broadly classified as Rhodophyta (red algae), Phaeophyta (brown algae), and Chlorophyta (green algae) and classified by size as macroalgae or microalgae. Macroalgae (seaweed) are multicellular, large-size algae, visible with the naked eye, while microalgae are microscopic single cells and may be prokaryotic, like cyanobacteria (Chloroxybacteria), or eukaryotic, like green algae (Chlorophyta). Among both, microalgae have gained wide recognition for their biofuel application due to superior growth rate, simple cell structure, and biomass composition. The productivity of these photosynthetic microorganisms that converts $CO_2$ into carbon-rich biomolecules (carbohydrates, proteins, and lipids) is only a step or two away from biofuels which in turn are produced by several chemical, biochemical, and thermochemical processes (Fig.1)[1]. A study reported in Science[2] about the broad prospect of microalgae over terrestrial crop-based biofuel mentioned how a 50-year-old concept came into focus during the oil crisis of the 1970s. Since then, millions of algal species have been isolated, identified, and studied for their biofuel potential. In addition, globally, algal biofuel has also been considered 3rd and 4th generation biofuel based on its potential over 1st and 2nd generation crop-based biofuels.

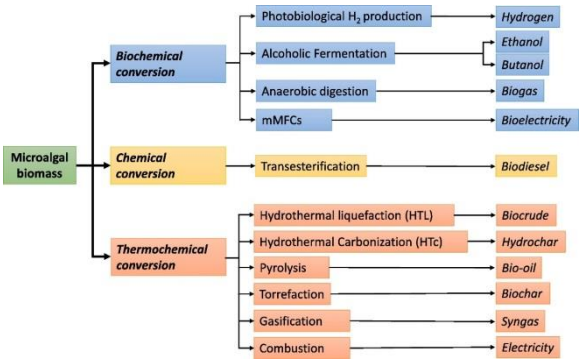


Fig. 1. A schematic of microalgal biomass to biofuel conversion techniques.

However, commercialization of the microalgal cultivation and biofuel production process deals with several challenges considering current capital costs per unit of fuel production. Moreover, high nutrients and



[1]Mishra, S., Roy, M., & Mohanty, K. (2019). Bioresourc. Technol., 292, 122008.
[2]Wijffels, R. H., & Barbosa, M. J. (2010). A Science, 329(5993), 796-799.

fresh-water requirements are critical constraints for producing economically sustainable microalgal bioenergy feedstock.

In this context, wastewater with substantial pollutants such as nitrogen, phosphorous, and organic carbon is a potential microalgal growth medium. This approach can simultaneously address bioremediation and generate high-value biomass feedstock. One such lab-scale study was done by an SSS-NIBE scientist, where domestic sewage wastewater was considered for microalgal cultivation, and the harvested biomass was processed for biofuel and biorefinery applications. Presently, a research team at SSS-NIBE is working to develop a large-scale microalgal waste wastewater treatment process that will use untreated sewage wastewater as an algal growth nutrient and the harvested biomass for biofuels such as biohydrogen and biogas production along with production nutraceuticals and high-value co-products.

## Green Hydrogen

The global demand for hydrogen is expected to grow significantly in the coming years. In 2020, the demand was estimated at 87 million metric tons (MT), and it is projected to reach 500-680 million MT by 2050[3]. Currently, over 95% of hydrogen production is based on fossil fuels, resulting in approximately 830 million tons of carbon dioxide ($CO_2$) emissions annually, equivalent to the combined emissions of the United Kingdom and Indonesia[4].

There are different methods of hydrogen production:

1.Natural Gas Reforming: Methane, found in natural gas, undergoes a process called steam methane reforming to produce hydrogen and carbon dioxide. This method is widely used for hydrogen production.

2.Gasification of Coal/Biomass: Coal or biomass is reacted with a sub-stoichiometric amount of oxygen and steam to produce a gas mixture called syngas. Hydrogen is separated from the syngas using pressure swing adsorption.

3.Water Electrolysis: Water ($H_2O$) is split into hydrogen ($H_2$) and oxygen ($O_2$) using electricity. This method can be powered by renewable energy sources, making it a clean and sustainable way to produce hydrogen.

Based on the source of energy and production method hydrogen is categorized under various colour codes:

• Brown/Grey Hydrogen: This is hydrogen produced from fossil fuels like natural gas and coal. It contributes to 95% of the current hydrogen demand and is not considered a low-carbon fuel due to $CO_2$ emissions during production.

• Blue Hydrogen: It follows the same production methods as brown/grey hydrogen, but the $CO_2$ emissions are captured and stored using carbon capture and storage (CCS)



[3]World Bank Blogs (2022), *Green Hydrogen: A key investment for the energy transition*
[4]IEA (2019), *The Future of Hydrogen*, IEA

technologies. Blue hydrogen is cleaner than grey hydrogen but has higher production costs due to the inclusion of CCS.

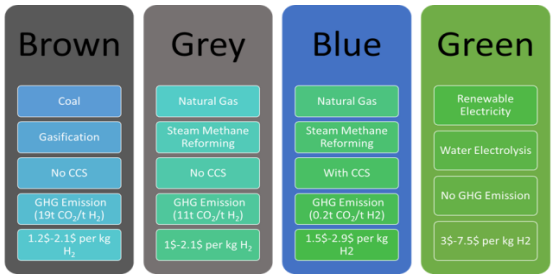


Fig. 2. Comparison of different Hydrogen Production Methods

• Green Hydrogen: It is produced by electrolysis, using electricity from clean energy sources like solar and wind. Green hydrogen is considered low or zero-emission hydrogen since renewable electricity generation does not release greenhouse gases. Although the production cost of green hydrogen is higher, it is more environmentally friendly than grey hydrogen

Green hydrogen has various potential uses across different sectors, including power generation, manufacturing processes, fuel cells for vehicles, shipping, ammonia production, and electricity grid stabilization (Fig. 3).

However, there are several challenges associated with green hydrogen, such as high production costs, lack of infrastructure for storage and transport, carbon-intensive current production methods, and regulatory and policy issues.

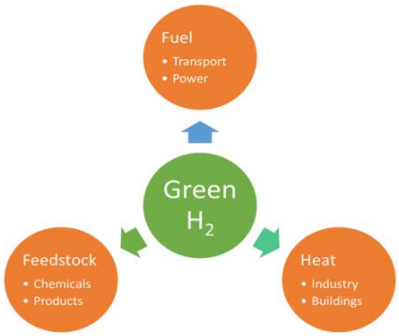


Fig. 3. Various Uses of Green Hydrogen

To overcome these challenges and promote the widespread utilization of hydrogen, opportunities lie in technology advancements to reduce costs, decentralized production near industrial ports, leveraging existing natural gas infrastructure, expanding hydrogen use in transportation, and facilitating global trade of hydrogen.

In summary, hydrogen demand is growing rapidly, and green hydrogen production is gaining attention as a cleaner alternative. While there are challenges to overcome, opportunities exist for technological advancements and infrastructure development to promote the wider adoption of hydrogen and decarbonize various industries.

# News and Events

## Bilingual Website Launch

We are thrilled to announce the formal launch of the new bilingual website (http://nibe.res.in/) at the SSS-NIBE. On April 13th, 2023, Director-General (DG) of SSS-NIBE proudly inaugurated the website in the

presence of SSS-NIBE staff at the meeting room.

We invite you to visit our new bilingual website (http://nibe.res.in/) and explore the wealth of information it has to offer.

## DBT Consultation Meeting: Integrated Bio-refineries and CCU

On April 26th, 2023, Dr. Rawel Singh from SSS-NIBE actively participated in a consultation meeting that aimed to develop a comprehensive roadmap for Integrated Bio-refineries and CCU (Carbon Capture and Utilization). This significant event, organized by the Department of Biotechnology (DBT) and the Biotechnology Industry Research Assistance Council (BIRAC), took place at the CSIR Science Centre in New Delhi. Key topics of the meeting:

• Roadmap for Integrated Biorefinery.

• Bridging Strategies for National Bio-economy Policy.

• Biobased Carbon Capture, Utilization, and Storage.

## R&D Conclave on Renewable Energy

On April 12th, 2023, Dr. Sachin Kumar, Scientist-C, made a significant contribution as an Expert Panelist during the esteemed "R&D Conclave on Renewable Energy". This enlightening conclave, organized by the Ministry of New and Renewable Energy in collaboration with the Shakti Foundation and RTI International, gathered leading experts and professionals in the field to discuss and explore the future of renewable energy.

Dr. Sachin Kumar's presence on the Expert Panel brought invaluable insights and expertise to the panel discussion, enriching the event with their deep knowledge and experience.


National Technology Day

## Celebrating National Technology Day: A Tribute to Innovation and Scientific Excellence

This day holds great significance as it marks the successful conduct of India's nuclear tests in Pokhran on May 11th, 1998, which showcased the nation's scientific prowess and technological capabilities. National Technology Day is not only a tribute to the success of our nuclear tests but also an opportunity to honor the spirit of innovation and technological advancements achieved by our scientific and industrial community. The highlight of the event was a captivating Guest Lecture delivered by Cdr. Gurkeerat

Sekhon (Retd), Executive Vice President-North Zone, Punjab Renewable Energy Systems Pvt. Ltd. His extensive experience and expertise in the field added tremendous value to the event, inspiring the audience with insights on renewable energy systems.

## Conference: Compressed Biogas (CBG): Potential, Technology, Policy, Operation, and Economics

Dr. Sanjeev Mishra, Scientist-D, and Dr. Sachin Kumar, Scientist-C, showcased their commitment to advancing knowledge and expertise in the field of Compressed Biogas (CBG) by participating in a three-day residential training program. The training, titled "Compressed Biogas (CBG): Potential, Technology, Policy, Operation, and Economics," was held at the esteemed Anil Agarwal Environment Training Institute in Nimli, Rajasthan, from April 11$^{th}$ to 13$^{th}$, 2023. The program was organized by the renowned Centre for Science and Environment, New Delhi.

## DG, SSS-NIBE's R&D Visit to Bangalore

From May 15$^{th}$ to 20$^{th}$, 2023, the DG, SSS-NIBE embarked on a fruitful visit to various R&D institutions in Bangalore. This visit aimed to foster collaboration and engage in discussions regarding ongoing and upcoming research projects with esteemed institutions such as the Indian Institute of Science, Jain University, and the Karnataka Renewable Energy Development Limited the state nodal agency.

During the visit, DG, SSS-NIBE held extensive discussions with representatives from these renowned institutions, focusing on exploring avenues for collaboration in research and development initiatives. The primary areas of focus revolved around training programs, as well as opportunities for piloting biomass projects in Karnataka.

## Mission Life Celebration

Government of India had proposed to United Nations for declaring 2023 as International Year of Millets (IYOM). The proposal of India was supported by 72 countries and United Nation's General Assembly (UNGA) declared 2023 as International Year of Millets on March 5$^{th}$, 2021. In this regard, the institute celebrated IYOM on May 24$^{th}$, 2023. During the event, a Guest Lecture was organized and delivered by Dr. Avneet Kaur, Assistant Professor, Krishi Vigyan Kendra, Kapurthala under Mission Life Celebrations.


Mission Life Celebration

## Honorable Visit by Dr. Ajay Mathur, Director General of the International Solar Alliance

We were honored to welcome Dr. Ajay Mathur, the esteemed Director General of the International Solar Alliance, to our institute on June 2nd, 2023. The visit was met with great excitement and enthusiasm from DG, SSS-NIBE, our scientists, and research fellows. Dr. Ajay Mathur was warmly greeted by DG, SSS-NIBE and scientific Staff, setting the stage for a productive and engaging interaction. Following a cordial introductory meeting, our scientific staff and research fellows had the opportunity to connect with Dr. Ajay Mathur, fostering knowledge exchange and collaboration.

The highlight of the visit was Dr. Ajay Mathur's insightful presentation on biomass-solar hybrid $H_2$ generation.

## DG, SSS-NIBE's R&D visit to Bologna, Italy

DG, SSS-NIBE attended the 31st EUBCE conference in Bologna, Italy, from June 5-9th, 2023, as a member of the Scientific Committee. The conference provided valuable insights into global research and innovation in the bioenergy sector, covering various conversion pathways. A promising research collaboration opportunity with ENEA, Italy was identified during a meeting at the conference, following the Joint Working Group meeting between India and Italy in February 2023. SSS-NIBE and ENEA's Department of Sustainability agreed to exchange information and work towards collaborative research. DG, SSS-NIBE also chaired an oral session on torrefaction and its development through process combinations, pilot-scale experiments, and kinetic modeling. The conference facilitated networking with international scientists and organizations, keeping SSS-NIBE updated on recent bioenergy advancements. This visit is expected to aid in benchmarking SSS-NIBE's research against global R&D and guide any necessary improvements.

## International Conference on Recent Advances in Bioenergy Research

Online call for abstract/paper submission announced for the 4rd International Conference on Recent Advances in Bioenergy Research (ICRABR), to be held at SSS-NIBE, Kapurthala between October 9 and 12th, 2023. Full length manuscripts are invited related to the conference themes mentioned below. All submitted manuscripts will undergo a peer review process for selection. Selected papers from the conference will be published in Scopus Indexed Proceedings and Journals after peer review. The details of the publication will be updated on the conference website. More details are available on: https://www.icrabr.com/.

**Broad themes/Tracks:**

- **Biomass Resource Management**
- **Biomass/waste conversion to energy**
- **Biomass Valorisation/ Waste to value added materials/ Products**
- **Modelling of Bio-energy system**
- **Biorefinery and Biohydrogen**

**Important Dates**

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| **Abstract or Extended Abstract submission** | **:** | 30 July 2023 |
| **Submission deadline for Abstract** | **:** | 30 July 2023 |
| **Deadline to avail early bird discount** | **:** | 1 August 2023 |
| **Final registration date for authors** | **:** | 15 September 2023 |

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