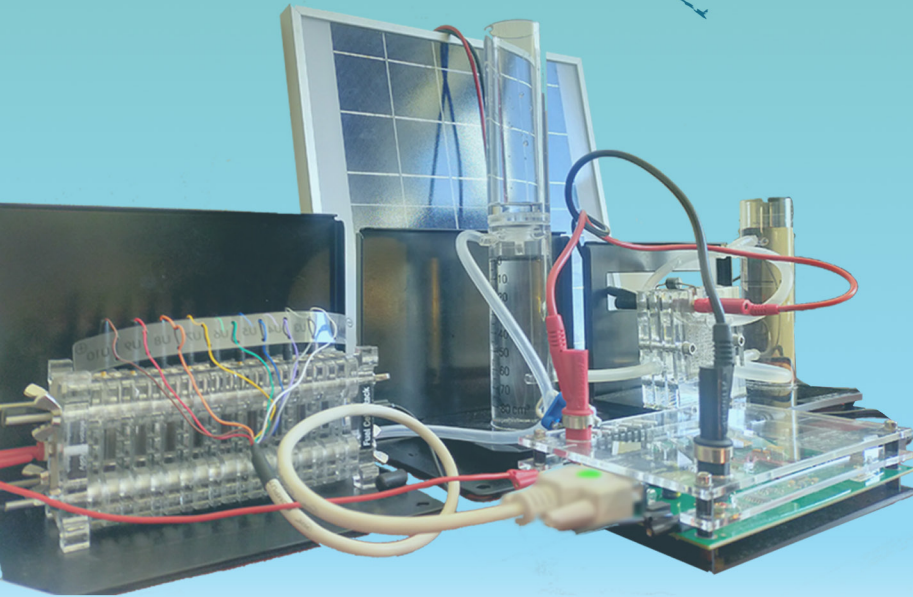




GREEN HYDROGEN LAB

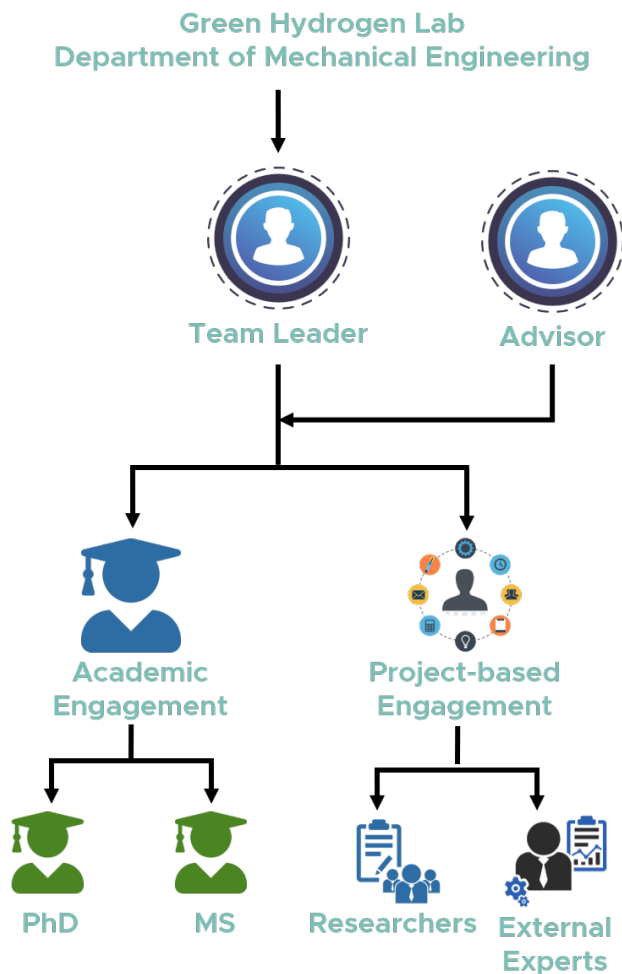
Second Anniversary Issue



GREEN
HYDROGEN
LAB

Green Hydrogen Lab
Department of Mechanical Engineering
Kathmandu University

Overview of GREEN HYDROGEN LAB



**GREEN
HYDROGEN
LAB**

Green Hydrogen Lab is a multi-disciplinary research lab established within Department of Mechanical Engineering, School of Engineering, Kathmandu University. Green Hydrogen Lab carries the following Mission and Vision

MISSION

Technology transfer, innovations, and local adaptation of green hydrogen energy systems in Nepal through continuous research and development activities.

VISION

Nepalese industries specialized to produce, store, transport, and use green hydrogen energy at a commercial level.

THE LOGO OF GREEN HYDROGEN LAB

The Vision of Green Hydrogen Lab (GHLab) is “Nepalese industries specialized to produce, store, transport, and use green hydrogen at a commercial level”. The logo of the Green Hydrogen Lab is a reflection of the vision it carries.

The core of the logo portrays the nucleus of Hydrogen with a water droplet representing Proton and Spark as its principal energy. The boundary of the core replicates the orbit of hydrogen with gear representing Electron.

The droplet at the center symbolizes renewable energy sources, which make hydrogen ‘Green’ or free from carbon footprints. The blue color of the water droplet represents the abundance of water on the planet earth. Water symbolizes the hydropower sector, which lays the foundation for the green hydrogen technologies in Nepal for socio-economic transformation.

The yellow color inside the electric spark depicts the fundamental nature of energy being omnipresent and omniscient. The green color in the spark represents the energy conversion process for producing clean hydrogen.

The black gear represents the industrial applications of green hydrogen for socio-economic developments. The full name ‘Green Hydrogen Lab’ is colored green highlighting GHLab’s goal to develop knowledge and technology supporting the global paradigm shift in the energy usage patterns to restore the depleting environment.



MESSAGE FROM THE VICE CHANCELLOR

The necessity for a green energy alternative to fossil fuels has been made more apparent by the escalation of climate change-induced environmental issues. Economic independence from fossil fuels will soon be a need rather than an option. The development of an independent green energy system must be able to meet the needs of the municipal and industrial sectors. University research is the first step in the growth and moderation of the production of independent energy and its efficient application. Kathmandu University stands as a powerful voice in Nepal, working to educate and train a generation of young change-makers, while also attempting to persuade the responsible policy-makers through research-based information.

Renewable energy is a hopeful perspective in a truly difficult present. In an effort to devise a long-term roadmap for the country to pursue, to understand the strengths and limitations of existing programs in renewable energy, Kathmandu University has been supporting and commissioning activities through renewable energy projects. The establishment and operation of Green Hydrogen Lab represent the university's interest in the global movement toward the acceptance of renewable energy and away from the deeply ingrained path of fossil fuels. Nepal is already in a state of economic and environmental crisis, and the future issues resulting from fuel dependency will be considerably more severe. Green Hydrogen Lab, through its research, explores for alternative solutions to avert the crisis before it is too late.

The lab was founded on the concept of "green hydrogen," and its current objective is to support Nepal's transition to renewable

energy sources, with hydrogen serving as a key component. In addition to meeting the nation's need for green energy, it can also offer a workable solution to the seasonal energy supply chain and storage issues that are stifling the Nepalese economy. The Green Hydrogen Lab has been carrying out studies to develop socio-economic, energy, and industrial-political frameworks as well as to identify initiatives that may be executed from a technological, legal, and economic standpoint to increase the acceptability of the renewable energy and lower atmospheric carbon.

Through its projects, Green Hydrogen Lab has also been in close cooperation with Germany, China, and Norway, three of the fast players in the hydrogen industry globally. The GHLab scholars are provided with the opportunity to witness cutting-edge technologies, improve their skills and abilities and also building a solid infrastructure and workforce for the future. I would want to take this opportunity express my best wishes and to thank every one of the Green Hydrogen Lab's stakeholders for their excellent efforts. We take great delight in the fact that the university has a department that is solely focused on promoting the generation of renewable energy from local resources. With the ultimate objective of assisting in Nepal's economic and climatic improvement, I hope that the lab will continue to strive to enhance society and broaden the exposure of its scholars and university in the following years.

Prof. Dr. Bhola Thapa
Vice Chancellor



MESSAGE FROM THE HEAD OF DEPARTMENT

As we step into another wonderful year, filled with hope and dreams for the Green Hydrogen Lab (GHLab) to reach new heights. The Green Hydrogen Lab at KU was established with the intention of using hydropower to develop a sustainable and environmentally friendly energy supply system for social and economic growth.

In the absence of adequate infrastructure for storage and delivery of excess electricity from hydropower, we will soon reach tolerable electricity levels. In this scenario, switching to green hydrogen will not only benefit the environment but also boost the economy by lowering the demand for petroleum imports for various purposes. Pressing climatic conditions necessitate a swift change to reduce carbon footprints in the environment. I believe green hydrogen is the future of Nepal's energy needs. The green hydrogen lab at Kathmandu University has done a good amount of work in a short span of time. The Lab is progressively moving toward building a foundation for the hydrogen economy in Nepal. Two years of hard work and dedication are now beginning to bear fruit in the form of various national-level initiatives, commercial agreements, etc.

I, on behalf of the Department of Mechanical Engineering, would like to congratulate all the

members of the GHLab team on the occasion two wonderful years of establishment. I have faith that the goals GHLab has set forth will be achieved in the years to come. The academic institutions, industries, and government have been working together in a single loop for the past year as part of the Green Hydrogen Lab to identify needs, transfer technology, and localize the green hydrogen economy system for the Nepalese market.

I'm pleased and proud that the Green Hydrogen Lab is part of my department. Green Hydrogen Lab carries the responsibility to change Nepal's growth trajectory by introducing Green Hydrogen Technologies. Even though hydrogen is an explosive element, it has the potential to ignite the nation's economy with the correct management techniques.

Lastly, I wish the team all success in their future expeditions.

Dr. Daniel Tuladhar
Head of the Department
Department of Mechanical Engineering





MESSAGE FROM THE TEAM LEADER

This year marks the second anniversary of the green hydrogen lab at Kathmandu University. Over these two years, Green Hydrogen Lab has built strong technological and policy foundations for Green Energy Transitions in Nepal. Through the strength of collaboration with various governmental, public, and private organizations, we have advanced one step closer to our goal of Green Hydrogen contributing to Carbon Neutral and Energy Independent Nepal.

Kathmandu University got an opportunity to contribute to the Green Hydrogen Coordination Committee under the secretariat of the Water and Energy Commission to conduct a study on the “Role of green hydrogen in balancing the demand and supply of hydropower electricity with low carbon and sustainable energy mix in Nepal”. The recommendations of the report were reflected in the national budget of Nepal 2079/80 (clause 257) “to initiate the commercial application of green hydrogen to contribute to the development of fuel, and energy in transportation, and the industrial sector”. The leaping step of government by making favorable policies has initiated activities at the commercial level in Nepal with several public and private sector planning for business opportunities. The recent partnership of Api Power Company Ltd, Nepal with Greenzo Energy Pvt. Ltd., India to establish a 50 MW green hydrogen and green ammonia project with the investment of 100 Billion NPR has brought Nepal among the nations pursuing the green hydrogen economy.

Nepal Government recently formed a committee and assigned the task to identify techno-

logical advancements and necessary policies to make Green Hydrogen-based Urea production feasible in Nepal. The national budget for 2079/80 has already included the policy for the establishment of the chemical fertilizers industry using Green hydrogen and green ammonia technology which will surely revolutionize Nepalese Agriculture industry.

KU has been partnering with several institutions and agencies to incubate new ideas, projects, and investment possibilities for commercial-scale projects in Nepal. The most interesting one is with Nepal Electricity Authority on “Pilot Scale Green Ammonia Production in Nepal for contribution to the domestic economy and better utilization of hydropower electricity”. The most challenging one is with the Bagmati Province government on “Design of Industrial Scale Green Urea Production in Nepal for Contribution to the Domestic Economy and Better Utilization of Hydropower Electricity”.

Green Hydrogen lab has made its best efforts in last two years to bring green hydrogen into the broad picture of energy transition in Nepal, leading to a sustainable, low carbon economy. The team is envisaged to encourage Nepalese industries specialized to produce, store, transport, and using green hydrogen energy at a commercial level through continuous research and development activities. We hope this is the beginning of a big game-changing event in the future of the energy mix of Nepal.

Biraj Singh Thapa, PhD
Team Leader, Green Hydrogen Lab
Associate Professor, DoME, KU

GH LAB TEAM MEMBERS



Dr. Biraj Singh Thapa
Team Leader



Prof. Dr. Bhola Thapa
Advisor



Brijesh Adhikary
Project Administrator



Samrat KC
Ph.D. Candidate



Nashla Shakya
Masters Candidate



Abhishek Subedi
Masters Candidate



Pralhad Gupta
Senior Researcher



Nitesh Yadav
Research Assistant



Rahul Ghimire
Research Assistant



Bishnu Pandey
Research Assistant



Prabhav Thapa
Research Assistant



Chandan Chaudhary
Intern Research Assistant



Sagar Niroula
Intern Research Assistant



Aman Kumar Shah
Intern Research Assistant



Mulyankan Sharma
Intern Research Assistant



Manish Sharma Timilsina
Intern Research Assistant



Yuvraj Chaudhary
Intern Research Assistant

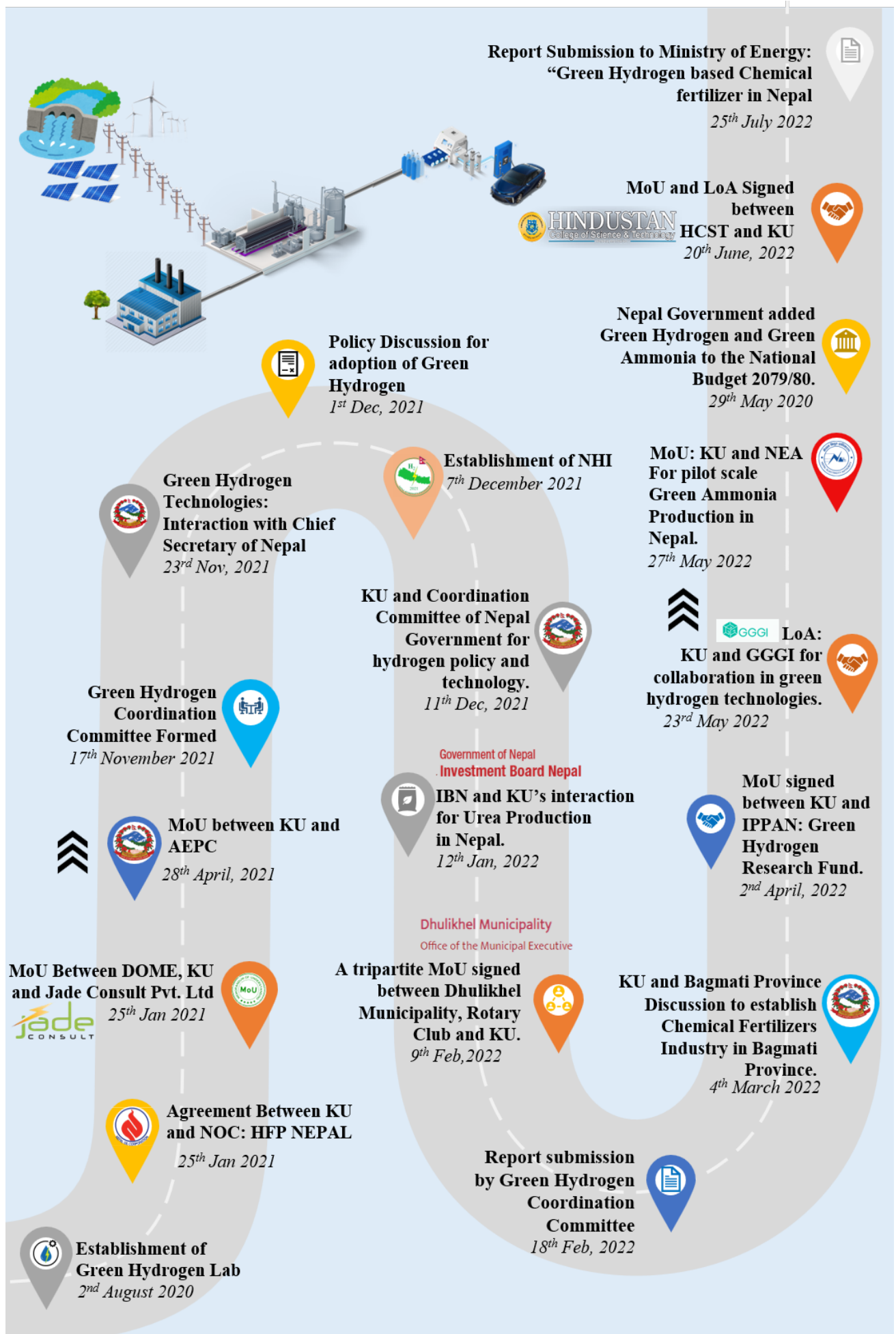


Aastha Shrestha
Intern Research Assistant



Hima Karki
Intern Research Assistant

GHLAB TIMELINE



ACTIVITIES OF SECOND YEAR

Interaction with National Assembly Members about Green Hydrogen.

13 August 2021

A delegation from the National Assembly, led by Mr. Jeevan Budha, a Member of the National assembly visited Kathmandu University. The team also visited the green hydrogen lab and discussed the nation's energy problems and the necessity of researching green hydrogen technology in Nepal to fix economic and environmental complications.

Green Hydrogen Training: A Media Perspective.

20 September 2021

The event titled "Green Hydrogen for Nepal: Media Perspective" was organized by Green Hydrogen Lab at Kathmandu University in collaboration with National Media Center and in support of Nepal oil cooperation (NOC) with the motive of understanding the media perspective on green hydrogen in Nepal. The main objective of this event was to connect media and stakeholders with the potential as well as challenges of green hydrogen technology in the context of Nepal. The significance of developing policies to assist the generation of green hydrogen for commercial usage was also enlightened.

Discussion for Green Hydrogen Initiatives with Energy Ministry.

28 September 2021

Energy Ministry of Nepal invited Dr. Biraj Singh Thapa, Team Leader of Green Hydrogen Lab to present on Green Hydrogen Initiatives. The discussion was mainly focused on Green Hydrogen and its potential future in Nepal. The need of Green Hydrogen Initiative from the governmental level was highlighted.

Interaction with Chief Secretary of Government about Green Hydrogen Perspective in Nepal.

23 November 2021

The meeting was held between the Chief Secretary of the Nepal Government and faculties of the Department of Mechanical Engineering, Kathmandu University. The focus of the discussion was the possibilities, opportunities, and role of the government for green hydrogen technologies in Nepal. This discussion further helped open doors at the governmental level for green hydrogen technologies.

Formation of Green Hydrogen Coordination Committee by Energy Minister of Nepal.

24 November 2021

A coordinate committee including members from WECS, MOEWRI, DOED, IOE, and KU was formed on 24th November 2021 by the Energy Minister of Nepal. The committee was formed to discuss the role of Green hydrogen in balancing the demand and supply of hydropower electricity with low carbon and sustainable energy mix in Nepal.

Enrollment of Masters by Research and Ph.D. Scholar's Academic Activities at Green Hydrogen Lab.

02 January 2022

A Ph.D. and a Master's student were enrolled in an academic program under the "Hydro-Himalaya project" funded by the Norwegian government with one-year and six-month exchange

opportunities respectively at the Norwegian University of Science and Technology, Norway. The Academic program is jointly supervised by experts from NTNU, Norway, and GHLab Team leader from Kathmandu University, Nepal.

Discussion with Investment Board Nepal (IBN) for Green Urea Production.

12 January 2022

An interaction program regarding “Urea production in Nepal” was held between Kathmandu University officials and OIBN. The interaction discovers Green Hydrogen as a primary requirement to boost Urea production in Nepal. The meeting further emphasizes reducing dependency on imports for Urea by collective roles of OIBN and Green Hydrogen Lab of Kathmandu University.

Discussion with High-Level Government Officials for Energy Management in Nepal.

07 February 2022

A meeting of high-level authorities including Ministers of Energy and Agriculture, the secretaries of four different Ministries, the MD of NEA, the CEO of IBN, and numerous other significant participants took part to discuss energy management in Nepal. The meeting focused on urea and Fertilizer Production in Nepal by utilizing green hydrogen technologies such as electrolysis. The roles of participants were discussed on an individual level for a smooth transition toward a green economy.

MoU and LoA Signed Between Kathmandu University, Dhulikhel Municipality, and Rotary Club of Dhulikhel.

09 February 2022

A tripartite MOU and LoA was signed between Dhulikhel Municipality, Kathmandu University, and the Rotary Club of Dhulikhel for “Piloting Green Hydrogen as a Fuel for Transportation and Clean Cooking contribution to carbon Neutral and Energy Independent Nepal”. It also includes the operation of two hydrogen-powered buses for the Dhulikhel to Kathmandu route in the span of five years.

Report Submission by Green Hydrogen Coordination Committee to Energy Ministry and Chief Secretary

18 February 2022

The coordinate committee formed under the secretariat of the Water and Energy Commission Submitted study report to the energy minister and chief secretary of the Nepal government. This study report contained steps toward carbon neutrality and energy independence and recommends government for policy-level intervention to open doors for incubation businesses around Green hydrogen technology from the private sector.

First Student Exchange to Germany.

24 February 2022

A master’s program was introduced as a part of the Nepal oil Cooperation (NOC) project titled “Technology Transfer and Local Adaptation to develop Nepal Oil Corporation as a Hydrogen Fuel Producing and Distributing Company (HFP-Nepal)”. The program was designed for two years with an exchange semester in one of Europe’s leading contenders in the production of Hydrogen and fuel cell technology i.e. Germany. The basic objectives were technology transfer and the acquisition of technical and academic skills in the hydrogen industry to guide future projects.

Interaction with Ministry of Agriculture and Livestock Development for Green Urea Production in Nepal.

03 March 2022

An interaction program for green Hydrogen and Urea Production in Nepal was held in the Ministry of Agriculture and Livestock Development. The feasibility of developing a Green Hydrogen and Urea production plant in Nepal was discussed. The detailed study of the parameters for the establishment was enlightened as a matter of concern.

MoU Signed Between KU and IPPAN.

02 April 2022

A MoU was signed between KU and IPPAN to promote and support hydropower energy for local commercial applications with a broad interest in carbon neutrality and energy independence in Nepal. A major part of the MoU signing was the establishment of the Green Hydrogen research fund. This MoU is effective for 5 years from the date of signing.

Demonstration of Electrically Retrofitted Car at Kathmandu University.

09 May 2022

A Maruti Suzuki car was electrically retrofitted by a group of undergraduate students under Green Hydrogen lab supervision. This car was the intermediate step in the conversion to fuel cell electric vehicle. This activity falls under the Nepal oil cooperation project entitled “Technology Transfer and Local Adaptation to develop Nepal Oil Corporation as a Hydrogen Fuel Producing and Distributing Company (HFP-Nepal)”.

LoA Signed Between KU and GGGI.

22 May 2022

A Letter of Agreement was signed between Kathmandu University (KU) and the Global Green Growth Institute (GGGI) to expand the collaboration in green hydrogen technologies, policies, and applications in Nepal. The LOA was based on the Memorandum of Understanding signed between both parties on April 20, 2021.

MoU Signed Between KU and NEA.

27 May 2022

A Memorandum of Understanding was signed by Nepal Electricity Authority (NEA) and Kathmandu University (KU) to promote green hydrogen technologies for improved domestic economic development and hydroelectric electricity consumption. The establishment of a joint-Project between KU and NEA for Pilot Scale Green Ammonia Production in Nepal was done for the contribution to the domestic economy and better utilization of Hydropower electricity.

Introduction of Green Hydrogen Policy in National Budget 2079/80.

29 May 2022

The Coordination Committee under the secretariat of the Water and Energy Commission submitted a report to the government on 18 February 22 suggesting policy-level interventions. As a result, green hydrogen was added to the national budget of 2079/2080 to initiate commercial application of green hydrogen for contribution to the development of fuel, and energy in transportation, and industrial sectors.

Translated Version of Nepal Budget 2079/2080

36. Activities will be initiated through Investment Board Nepal to establish a chemical fertilizer plant using green hydrogen and green ammonia technology.

257. Necessary activities will be initiated for the commercial use of hydrogen energy to contribute to the overall development of Nepal's fuel and energy consumption, transport, and industrial sectors.

Formation of Committee to Study Hydrogen-based Urea Production in Nepal.

05 July 2022

A committee at the ministerial level by the Ministry of Energy, Nepal Government was formed to identify the technological advancement and necessary policies to make hydrogen-based Urea Production feasible in Nepal. The committee was expected to submit a report to the ministry of Energy by the end of the month.

Report Submission to Ministry of Energy titled "Green Hydrogen Based Chemical Fertilizer in Nepal".

25 July 2022

The Committee for Green Hydrogen-based Chemical Fertilizer in Nepal has submitted the report to the Minister of Energy. The technology, Policy, and Collaboration model have been proposed. It is expected Nepal to have its first Urea production Industry soon.

MoU inception Meeting Between KU, Dhulikhel Municipality, and Rotary Club of Dhulikhel

27 July 2022

The meeting was a follow-up to the earlier-signed memorandum of understanding for the pilot project "Green Hydrogen as an Alternative Fuel for Transportation and Clean Cooking Contributing to Carbon Neutral and Energy Independent Nepal." The future plan was discussed between the mayor, the Dhulikhel Municipality, representatives from the Rotary club, and Kathmandu University. An electrically retrofitted Maruti 800 was demonstrated. Mayor further encouraged GHLab by assigning two electrical conversion tasks for Dhulikhel Municipality.

INTERNATIONAL BREAKTHROUGH IN HYDROGEN TECHNOLOGY

Toyota Mirai hydrogen car sets official Guinness World Records for longest distance travel of 1360 km on a tank of 5.65kg hydrogen fuel, establishing a new distance benchmark for zero-emission vehicles.



Powered by 190-kW hydrogen fuel cell system, Hyundai XCIENT Fuel Cell can travel approximately 400 km on a single charge.

Alstom unveiled the world's first hydrogen-powered passenger train. The train features several different innovations: clean energy conversion and efficient energy supply and storage system combined with intelligent energy management.

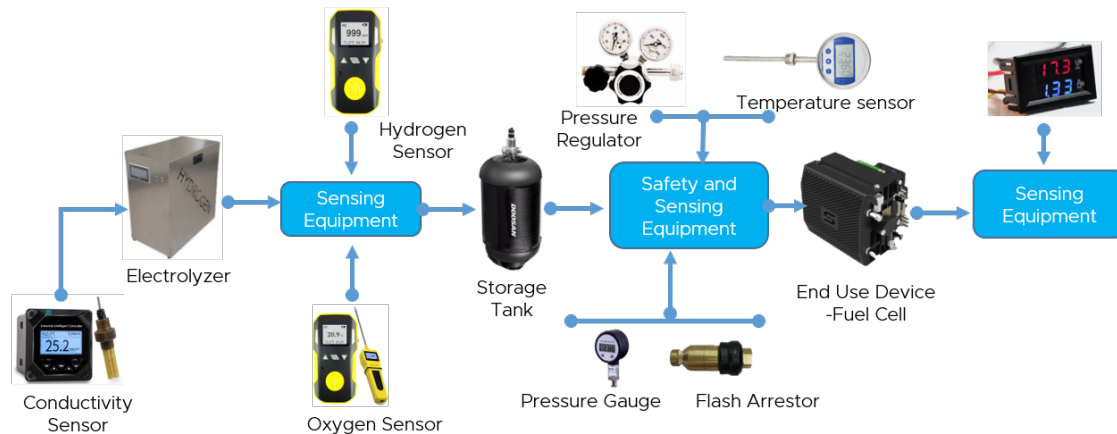


PROJECTS



KU-AEPC Project

Title: “Setting up a demonstrative facility for commercial application of Green hydrogen technologies in Nepal within Green Hydrogen Lab, DoME, KU”



Application Area: Alternative Renewable Energy Promotion of commercial applications
Rural access to electricity

Commenced Date: 28 April 2020

Budget: NRs. 1,997,982

Funding Agency: Alternative Renewable Energy Promotion Centre

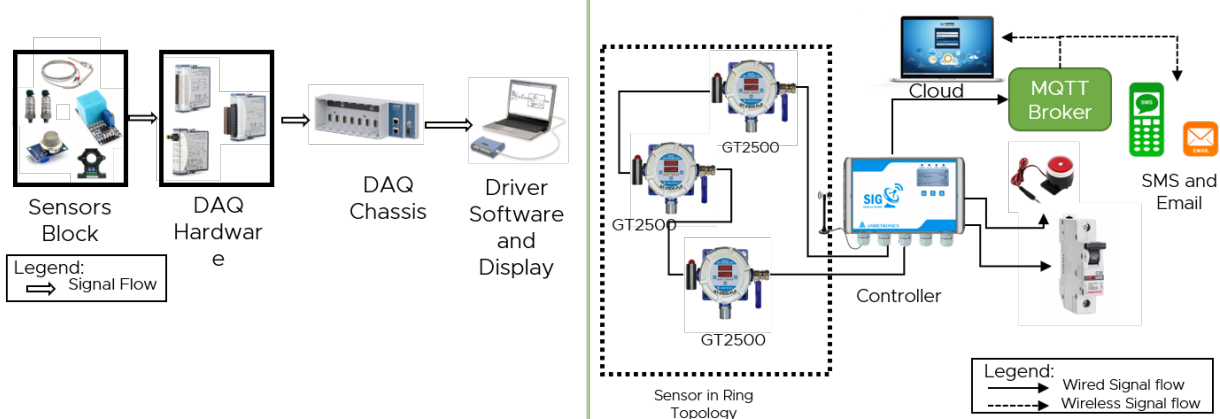
Project Duration: Six months

Current Project Status: Completed



KU-Jade Project

Title: “Establish a foundation for the cooperation with Mechanical Engineering aspects of alternative energy including hydropower and green hydrogen.”



Application Area: Data Acquisition in Research of Green Hydrogen Technologies

Commenced Date: 25 February 2021

Budget: NRs. 1,000,000

Funding Agency: JADE Consult

Project Duration: Two Years

Current Project Status: Completed

Title: “Technology Transfer and Local Adaptation for Developing NOC as Hydrogen Fuel Producing and Distribution Company”



Application Area: Green Fuel in Transportation Sector

Commenced Date: April 2021

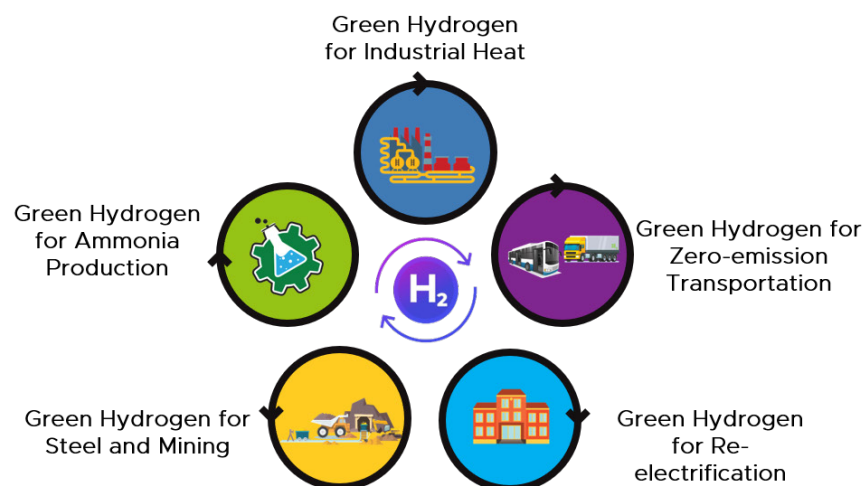
Budget: NRs. 49,969,000

Funding Agency: Nepal Oil Corporation

Project Duration: 24 Months

Current Project Status: Ongoing

Title: “Incubation of Nepal Hydrogen Initiative Program”



Application Area: Hydrogen System Advocacy, Foundation for Hydrogen Economy in Nepal, Policies Related to Hydrogen

Commenced Date: 01 January 2022

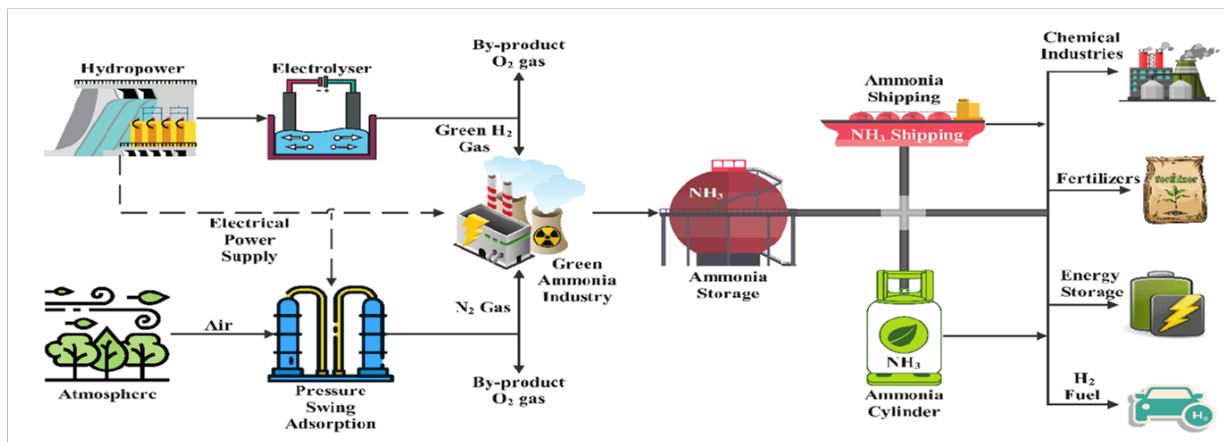
Budget: NRs. 12,565,000

Funding Agency: Norwegian Embassy and NORAD

Project Duration: 24 months

Current Project Status: Ongoing

Title: "Pilot scale green ammonia production in Nepal for contribution to the domestic economy and better utilization of hydropower electricity"



Application Area: Industrial Use and Ammonia as Fertilizer

Commenced Date: June 2022

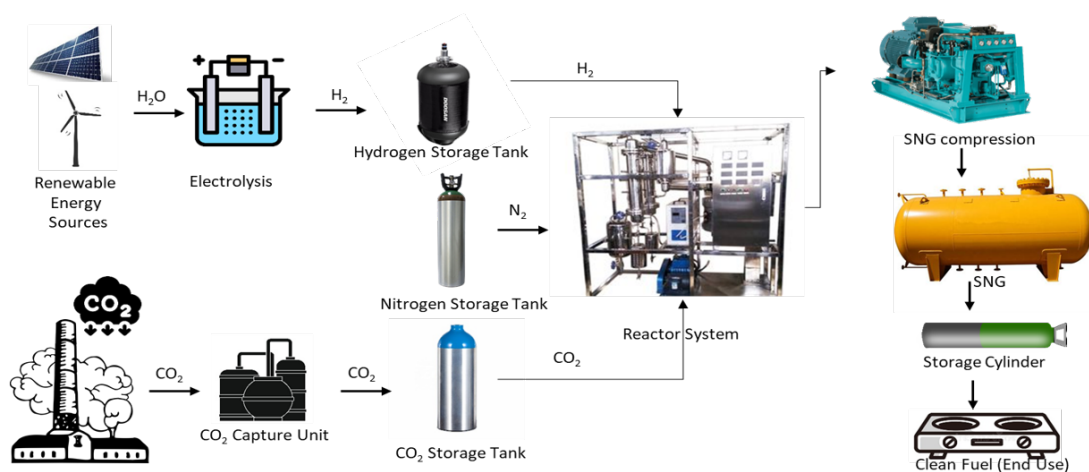
Budget: NRs. 30,000,000

Funding Agency: Nepal Electricity Authority

Project Duration: 2 years

Current Project Status: Ongoing

Title: "Incubation of Synthetic Natural Gas Production Enterprise for Utilization in Cooking Sector"



Application Area: Alternative and Renewable Energy

Commenced Date: 20 May 2022

Budget: NRs. 8,983,230

Funding Agency: Korean International Cooperation Agency (KOICA)

Project Duration: 14 Months

Current Project Status: Ongoing



KU-Bagmati Government Project

Title: “Detailed Feasibility Study for Production of Urea Fertilizer.”



Application Area: Green Urea from Green Hydrogen

Commenced Date: 22 June 2022

Budget: NRs. 5,000,000

Funding Agency: Agriculture and Livestock Development Ministry, Bagmati Province

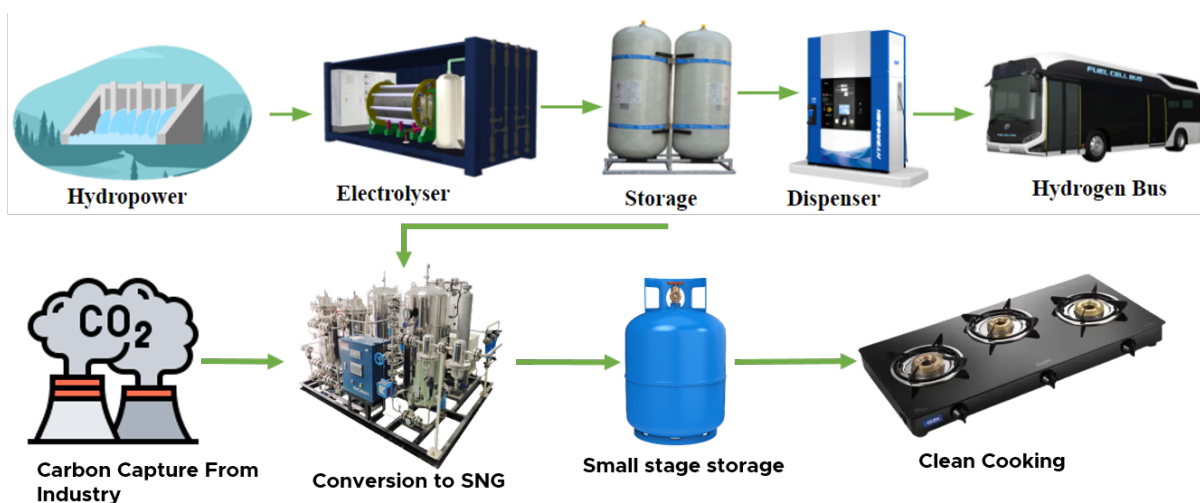
Project Duration: 12 months

Current Project Status: Ongoing



KU-Dhulikhel Municipality and Rotary Club of Dhulikhel Project

Title: “Piloting Green Hydrogen as a Fuel for Transportation and Clean Cooking Contributing to Carbon Neutral and Energy Independent Nepal”



Application Area: Clean Transportation and Clean Cooking

Commenced Date: February 2022

Budget: NRs. 100,000,000

Funding Agency: Basket Fund from Different Agencies

Project Duration: 5 years

Current Project Status: Ongoing

Title: “Development of Green Hydrogen research Fund”



Application Area: Hydropower and Green Hydrogen

Commenced Date: 2 April 2022

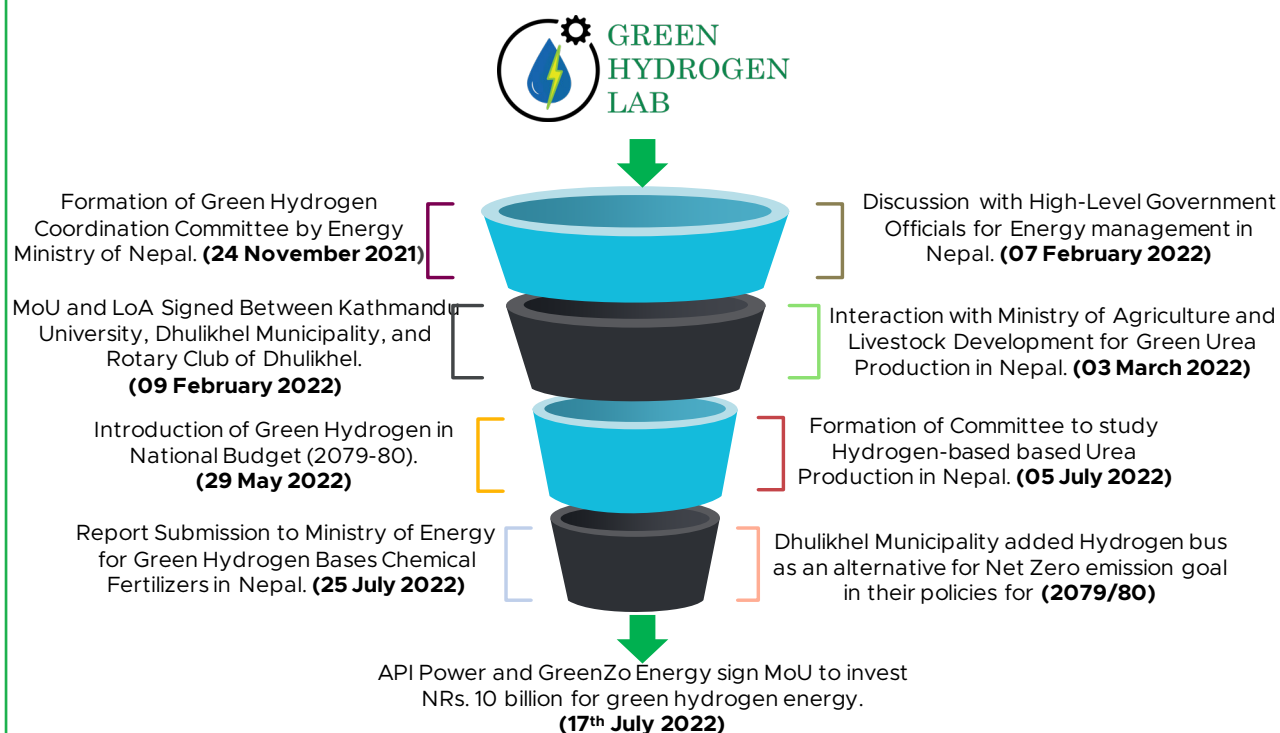
Budget: NRs. 50,000,000

Funding Agency: IPPAN Members and External Sources

Project Duration: 5 Years

Current Project Status: Ongoing

PAVING THE PATH GREEN HYDROGEN ECONOMY IN NEPAL



POST GRADUATE ACADEMIC ENGAGEMENT

IMPROVEMENT OF FUEL CELL PERFORMANCE USING ORDERED MICROSTRUCTURAL DESIGN

Objectives:

1. Optimization of the geometry of the ordered structure was used in the previous work of Hoem (2021).
2. Numerical modelling and simulation of the ordered structure and analyzing the performance.
3. Experimental investigation of the optimized geometry of microstructures used in GDL to verify the numerical investigation.



PhD Candidate

Samrat KC
Mechanical Engineer
14ksamrat@gmail.com

Funding Source: Hydro-Himalaya Project at School of Engineering Kathmandu University

Supervisors:

Dr. Biraj Singh Thapa, Assoc. Professor, Department of Mechanical Engineering, KU.

Dr. Frode Seland, Professor, Department of Materials Science and Engineering, NTNU

Dr. Jan Torgersen, Professor, Department of Mechanical and Industrial Engineering, NTNU



Masters Candidate

Nashla Shakya
Mechanical Engineer
nashla.shakya@ku.edu.np

GREEN HYDROGEN AS AN ALTERNATIVE AND FUTURE FUEL FOR TRANSPORTATION SECTOR OF NEPAL

Objectives:

1. Evaluate the need of renewable energy systems and technological status to replace fossil fuel from the transportation sector.
2. Techno-economic assessment of the use of green hydrogen as an alternative and future fuel in the transportation sector of Nepal.
3. Identify and propose an optimum case for pilot scale testing of green hydrogen as a fuel for the transportation sector of Nepal at a commercial level.

Funding Source: KU-NOC Project at Kathmandu University

Supervisors:

Dr. Biraj Singh Thapa, Assoc. Professor, Department of Mechanical Engineering, KU.

Prof. Dr.-Ing. Rajesh Saiju, Hochschule Flensburg University of Applied Sciences

QUANTITATIVE RISK MITIGATION MODEL FOR HYDROGEN VALUE CHAIN

Objectives:

1. Study hydrogen value chain in relation to the different energy sources and end-use applications.
2. Study hydrogen behavior models to identify associated consequences and define safety parameters.
3. Quantitative risk assessment for consequence modeling and risk mitigation of specific hydrogen safety challenge.



Masters Candidate

Abhishek Subedi
Mechanical Engineer
abhishek.subedi@ku.edu.np

Funding Source: Hydro-Himalaya Project at School of Engineering Kathmandu University

Supervisors:

Dr. Biraj Singh Thapa, Assoc. Professor, Department of Mechanical Engineering, KU.

Dr. Nicola Paltrinieri, Professor, Department of Mechanical and Industrial Engineering, NTNU

UNDERGRADUATE PROJECTS: COMPLETED (2021/2022)

1. DESIGN AND DEVELOPMENT OF DRIVE SYSTEM AND SAFETY CONSIDERATIONS FOR A DEMONSTRATIVE FUEL CELL DRIVEN CAR

Supervisor: Dr. Biraj Singh Thapa

Advisor: Nitesh Kumar Yadav

Students: Pawan Paudel, Manish Sapkota, Yaju Shrestha, Abhishek Subedi

2. CONVERSION OF AN IC ENGINE CAR CHASSIS TO BE USED FOR A DEMONSTRATIVE FUEL CELL DRIVEN HYDROGEN CAR

Supervisor: Dr. Biraj Singh Thapa

Advisor: Nitesh Kumar Yadav

Students: Nabin Mishra, Biraj Kharel, Abhishek Mishra, Tej Raj Tharu

3. DESIGN AND DEVELOPMENT OF HYDROGEN TRANSMISSION AND REFUELING STATION FOR RESEARCH PURPOSE

Supervisor: Dr. Biraj Singh Thapa

Advisor: Nitesh Kumar Yadav

Students: Abin Thapa, Mirdul Bhattarai, Sangam Limbu, Shrayad Chapagain

4. DEVELOPMENT OF HYDROGEN PRODUCTION AND STORAGE SYSTEM FOR THE DEMONSTRATIVE USE IN THE TRANSPORTATION SECTOR OF NEPAL

Supervisor: Dr. Biraj Singh Thapa

Advisor: Abhishek Subedi

Students: Himanshu Giri, Rohit Joshi, Vikram GC

5. SYSTEM DESIGN AND OPTIMIZATION OF SAFETY MANAGEMENT IN HYDROGEN VALUE CHAIN FOR NEPAL

Supervisor: Dr. Biraj Singh Thapa

Advisor: Abhishek Subedi

Students: Narendra Chaudhary, Ashim Khanal

INTERNATIONAL BREAKTHROUGH IN HYDROGEN TECHNOLOGY

GKN Hydrogen produces a 10-25 Kg metal hydride-based storage system capable of storing 165-420 kWh electrical energy



CEMEX successfully deploys hydrogen-based ground-breaking technology as part of its fuel mix in all of its cement plants in Europe. This innovative technology using hydrogen, which emits zero CO₂ from combustion also improves energy efficiency and consequently is another milestone towards CO₂ emissions reduction targets.

The global steel industry is on the verge of a “titanic pivot” from coal to hydrogen as its main source of energy. Green Hydrogen has the potential to be the cheapest energy source accounting for 31% of the global market.



UNDERGRADUATE PROJECTS YEAR: 2022/2023

- 1. DEVELOPMENT OF SYSTEM MODEL FOR HYDROGEN RISK ANALYSIS**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Abhishek Subedi
Students: Sagar Niroula
- 2. DEVELOPMENT OF STANDARD OPERATING PROCEDURE AND SAFETY GUIDELINES FOR ONSITE HYDROGEN REFUELING STATION**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Nitesh Kumar Yadav
Students: Anish Adhikari, Raman Bagale, Nirmal Godar
- 3. DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF PROTON EXCHANGE MEMBRANE FUEL CELL**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Samrat KC
Students: Ujjwal Dhakal, Prajwal Karki, Deependra Thakuri
- 4. OPTIMAL SIZING AND DESIGNING OF AN ON-SITE HYDROGEN REFUELING SYSTEM FOR A FLEET OF FC BUSES IN THE DHULIKHEL-KATHMANDU ROUTE**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Pralhad Gupta
Students: Dhruvabar Singh K.C., Nawaraj Kafle, Tej Prasad Phuyal
- 5. DESIGN AND DEVELOPMENT OF A LOW-COST HYBRID FUEL CELL ELECTRIC TWO-WHEELER**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Pralhad Gupta
Students: Asamanta Thapa, Gajendra Yadav, Jyotish Kumar Jha, Safal Shrestha
- 6. DESIGN AND DEMONSTRATION OF SNG BASED HEATING APPLICATION**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Bishnu Pandey
Students: Ashutosh Dev, Sunam Amatya, Yogesh Dumre
- 7. MODEL DEVELOPMENT AND VALIDATION OF SNG PRODUCTION UNIT**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Prabhav Thapa
Students: Raju Bhattarai, Anish Khanal, Niraj Panta
- 8. MODELING, VALIDATION OF PEM FUEL CELL HUMIDIFICATION SYSTEM**
Supervisor: Dr. Biraj Singh Thapa
Advisor: Rahul Ghimire, Samrat KC
Students: Gokarna Bahadur Thapa, Alice Rana, Jayanti Thakur, Umesh Jung Thapa



A SEMESTER IN GERMANY

Nashla Shakya MS by Research Candidate

Green Hydrogen lab, Department of Mechanical Engineering, Kathmandu University signed a project with Nepal Oil Corporation for "Technology Transfer and Local Adaptation to develop Nepal Oil Corporation as a Hydrogen Fuel Producing and Distributing Company (HFP-Nepal)". The aim of this project



was to encourage academic and research engagement within a broad interest of business development possibilities in the transportation sector and policy level recommendation for Government of Nepal emphasizing production, storage, end-use of Green Hydrogen as green fuel for Nepal. As a part of this project, a Master by Research Program was initiated. The outputs of this Master Program was to conduct feasibility analysis with respect to technology and economy. The master program was planned to be 2 years long with one exchange semester in one of Europe's leading contender in production of hydrogen and fuel cell technology, Germany with the help of relations of Kathmandu University with German University, Flensburg University of Applied Sciences (FUAS, Hochschule Flensburg).

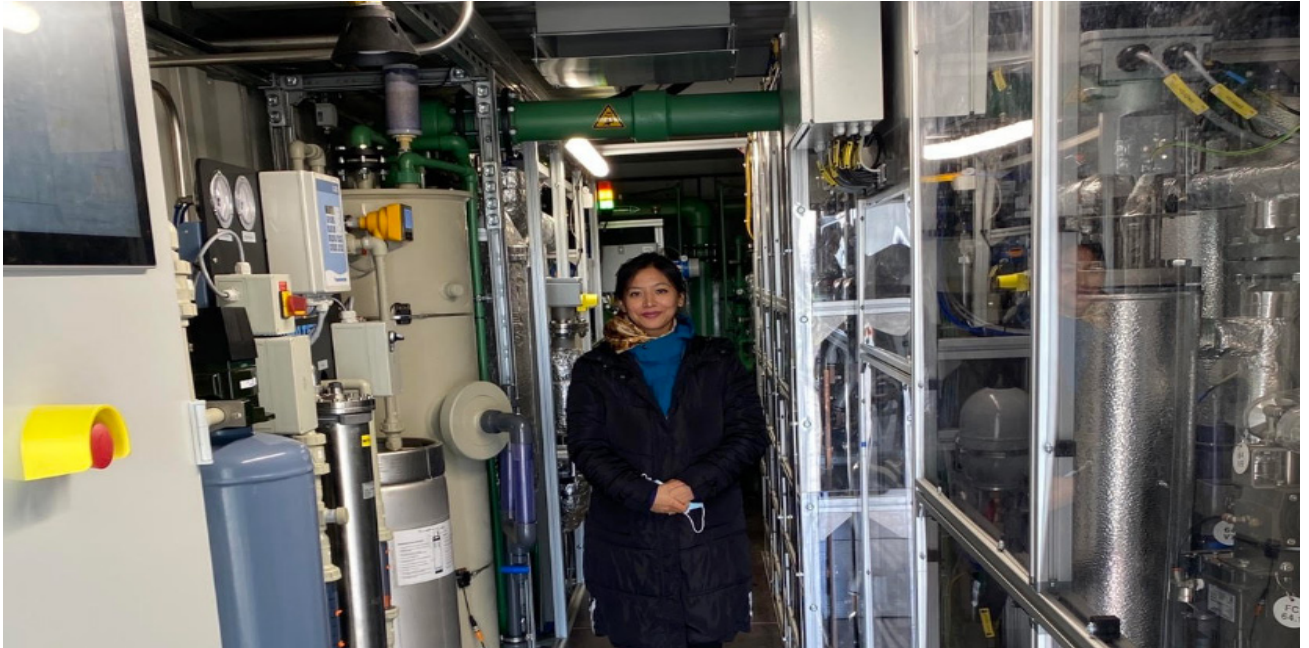
The expectations of the exchange program is that dissemination of such knowledge and information through student exchange programs can be advantageous for planning future hydrogen projects and preparatory works for the industrial development of hydrogen in Nepal. The exchange program has the following objectives.

- » Knowledge and technology transfer from University of Applied Physics Flensburg to Kathmandu university through the student exchange program
- » Data acquisition of fuel cell vehicle parameters for pilot planning of KU Master program
- » Acquisition of technical and academic skills about hydrogen industry from an international hydrogen production company to guide future projects, academic programs, and hydrogen business planning in Nepal

Green Hydrogen Lab's first MS by Research Candidate, Ms. Nashla Shakya was the one taking part in the first exchange session of Green Hydrogen Lab. In this program, she pursued her MS courses by taking courses in Hochschule Flensburg, FUAS. The grades will be transferred to her home institution. Parallely, she also got the opportunity work as a industrial trainee in one of the biggest Biogas company from Northern Germany, Nissen Biogas. Nissen Biogas is a biogas company using renewable energy from wind and solar to produce synthetic natural gas, methane and providing heat and electricity to the communities in the North of Germany. Ms. Shakya was part of the technical and economic analysis project of the company to introduce hydrogen in its system to increase the efficiency of methane production. Under the supervision of company owner, Dirk Nissen and company Engineer, Alexander Kroggel, PhD. she contributed to project. Besides the course and training program, Ms. Shakya got the chance to witness many state of the art hydrogen project throughout Germany. She got to take part in the world's

biggest renewable energy fair, the Hannover Messe where she got the chance to collect many information on hydrogen and renewable energy technology and information about suppliers for the whole value chain of Hydrogen.

Through such exchange program, the scholars of GHLab get the opportunities to explore the state of the art technologies in the world, learn tools and theories for economic analysis and scenario simulations about hydrogen in world class universities. It is a prominent way to learn from the best and try to apply it in Nepal in most relevant way possible. Green Hydrogen lab is proud to have such programs in the university that will develop skills amongst scholars and add value to university's intellectual assets.



Ms. Shakya inside 1 MW Electrolyser of Project Wind Harup, Germany



Shakya in Main Head Quarters GP Joule, Germany in front of Tube trailers of Hydrogen and 250 kW Electrolyser of eFarm Project

PUBLICATIONS: JOURNAL PAPER

1. **Green Hydrogen as a Future Multi-disciplinary Research at Kathmandu University**
Biraj Singh Thapa and Bhola Thapa
Journal of Physics: Conference Series: Volume 1608, Current Research in Hydropower Technologies (CRHT X) 31 March 2020, Kathmandu University Nepal.
doi: [10.1088/1742-6596/1608/1/012020](https://doi.org/10.1088/1742-6596/1608/1/012020)
2. **Green Hydrogen potentials from surplus hydro energy in Nepal**
Biraj Singh Thapa, Bishwash Neupane, Ho-Seong Yang, Young-Ho Lee
International Journal of Hydrogen Energy, Volume 46, Issue 43, 23 June 2021, Pa-es 22256-22267, <https://doi.org/10.1016/j.ijhydene.2021.04.096>
doi: [10.1016/j.ijhydene.2021.04.096](https://doi.org/10.1016/j.ijhydene.2021.04.096)
3. **Parametric modeling of re-electrification by Green Hydrogen as an alternative of backup power**
Abhishek Subedi and Biraj Singh Thapa
Published under license of IOP Publishing Ltd
IOP Conference Series: Earth and Environmental Science, Volume 1037, 3rd IAHR- Asia Symposium on Hydraulic Machinery and Systems (IAHR-Asia 2021) 22/11/2021 – 23/11/2021 Dhulikhel, Kavre, Nepal
doi: [10.1088/1755-1315/1037/1/012057](https://doi.org/10.1088/1755-1315/1037/1/012057)
4. **Hydrogen as a fuel for electrifying transportation sector in Nepal: Opportunities and Challenges**
N Shakya¹, R Shrestha², R Saiju³, and B S Thapa^{1*}
* Corresponding author (bst@ku.edu.np)
IAHR-Asia 2021, IAHR-Asia Symposium on Hydraulic Machinery and Systems 22nd – 23rd November, Kathmandu, Nepal
doi: [10.1088/1755-1315/1037/1/012064](https://doi.org/10.1088/1755-1315/1037/1/012064)

POPULAR MEDIA

1. [Dr. Biraj Singh Thapa \(Head, Hydrogen lab,KU\) | Good Morning Nepal| 02.08.2021](#)
2. [On Air With Sanjay #049 - Biraj Singh Thapa | 06.09.2021](#)
3. [Green Hydrogen for Nepal: A Documentary Video | "Next Step" 23.01.2022](#)
4. [Can Nepal transit to a green hydrogen economy? The Annapurna Express| 23.01.2022](#)
5. [Bhusal's Commitment To Provide Electricity Needed To Increase Green Hydrogen Use In Chemical Fertilizer Production | 24.01.2022](#)
6. [Green Hydrogen Commercial Product Is Necessary For The Necessary Policy| 18.02.2022](#)
7. [Discussion on alternative to Petroleum fuel. Badalido Nepal | 07.04.2022](#)
8. [Kathmandu University Making Hydrogen Car and Bus. TechPana | 04.05.2022](#)
9. [LoA signed between Kathmandu University \(KU\) and Global Green Growth Institute \(GGGI\) 25.05.2022](#)
10. [MoU between Kathmandu University and Electricity Authority to use Hydrogen Technology 27.05.2022](#)
11. [The Finance Minister said to the experts of KU Hydrogen Lab - Let's prepare to install a 100 megawatt plant | 21.06.2022](#)
12. [KU to study the feasibility of fertilizer factory | 24.06.2022](#)
13. [NEA Talk Show "Green Hydrogen for Carbon Neutral and Energy Independent Nepal". Dr. Biraj Singh Thapa | 29.07.2022](#)

VEHICLE CONVERSION PROJECT

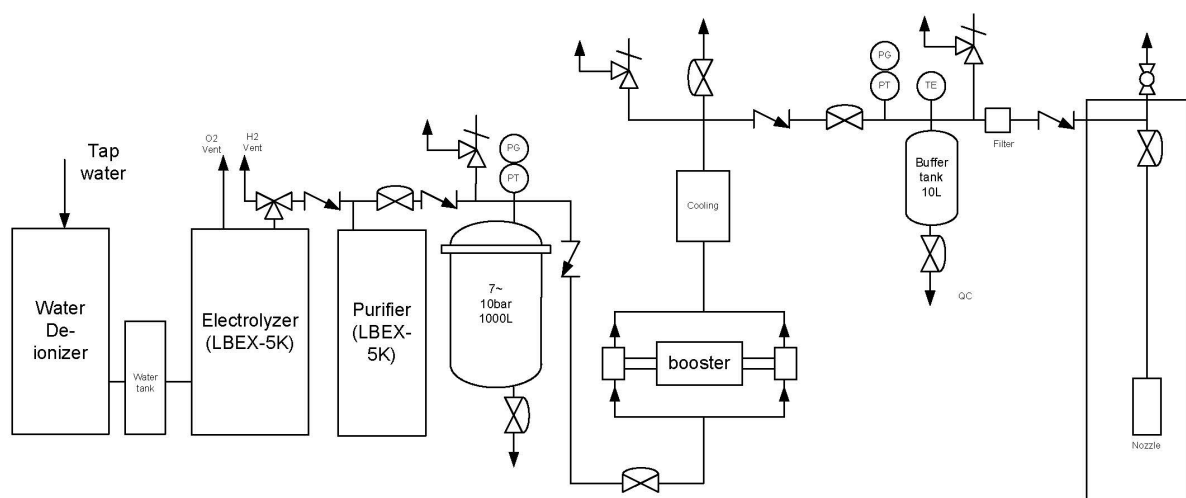
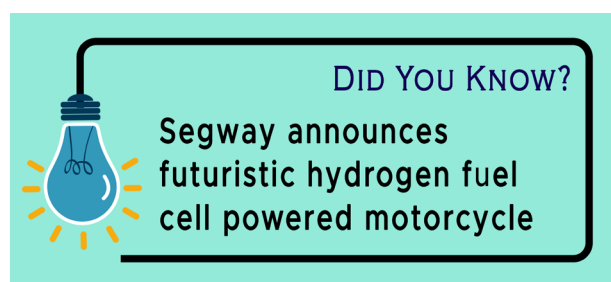
IC TO ALL ELECTRIC VEHICLE

SUMMARY OF PROJECT:

Kathmandu University and Nepal Oil Corporation signed a MoU and has been working on the project entitled, “**Technology Transfer and Local adaptation for developing Nepal Oil Corporation as hydrogen fuel producing and distributing company**”. One of the objective of the project is the conversion of Internal combustion engine vehicle to all electric vehicle. For demonstration of retrofitting process, a 20 year old vehicle, Maruti 800 has been selected. Maruti 800 was retrofitted by undergraduate students under the supervision of Green Hydrogen Lab. The vehicle conversion was completed in the Technical Training Center, Kathmandu University. The vehicle conversion carried out locally paves the path for retrofitting possibilities within Nepal.



ATTRIBUTES	SPECIFICATIONS
Kerb weight	850 kg
Motor Power	6 kw (BLDC Type)
Battery capacity	100 Ah (72 V)
Payload Capacity	400 kg
Range	45 km
Charging time	4-5 hours
Max Gradiability	25 %



Refueling Station Schematics

GHLAB LABORATORY EQUIPMENTS

1 kW HYDROGEN EXPERIMENT SETUP

A 1 kW hydrogen value chain model is setup at Green Hydrogen lab as advanced research equipment. It has 1 kW hydrogen production system, 17 L storage tank and 150 W End use device for reelectrification. Auxiliaries equipment are setup for safety and data logging. The set has 11 different equipment representing the aspects of value chain of hydrogen; production (electrolyzer), storage (tank, safety, and sensing equipment), and end-use (fuel cell for re-electrification).

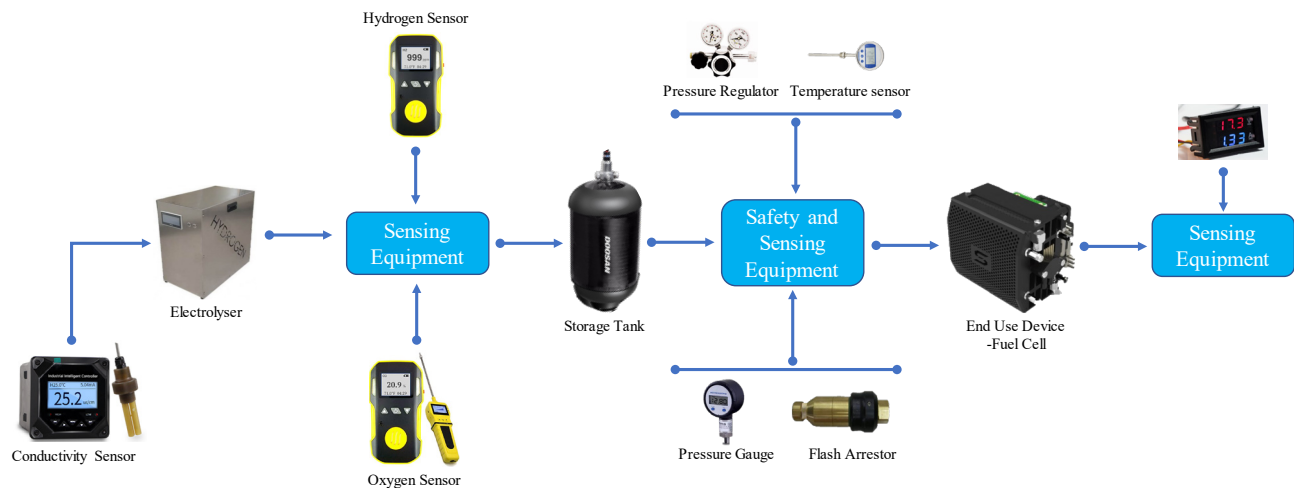


Figure: 1 kW Hydrogen Experiment Setup

DATA ACQUISITION SYSTEM

The data acquisition system at Green Hydrogen Lab includes sensors for acquiring data from the experiment performed and analysis of the acquired data. The current, voltage sensors, hydrogen pressure transducer, temperature sensors available are setup with the data acquisition hardware from National Instruments for data logging, real time data monitoring, and analysis.

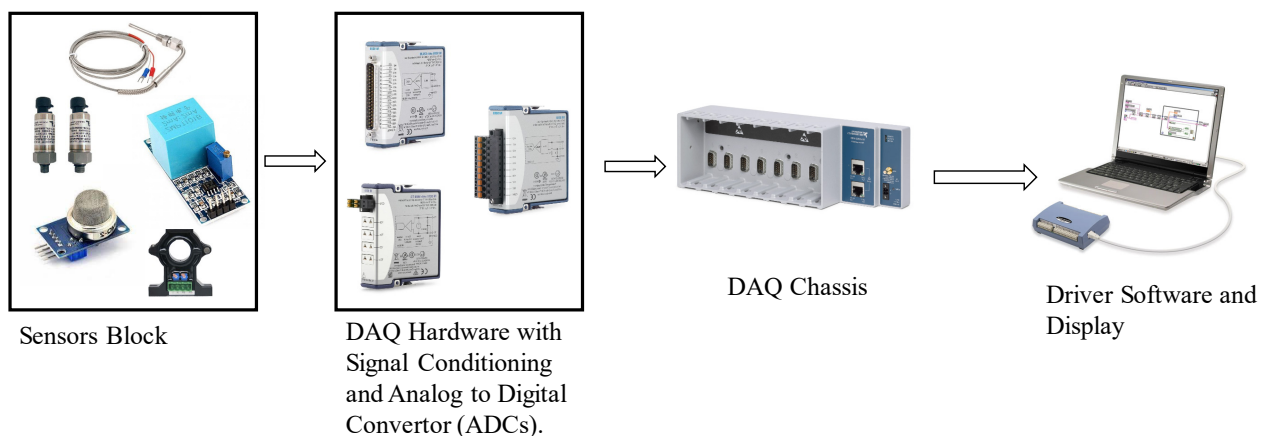


Figure: Data Acquisition System

GALLERY



MoU inception meeting between KU, Dhulikhel Municipality and Rotary Club of Dhulikhel



Prof. Dr. Ole Gunnar Dahlhaug, Assoc. Prof. Dr. Biraj Singh Thapa and Prof. Peter and Petter Stoa, Vice President of Sintef Energy Research



MoU inception meeting between KU and NEA



LoA was signed between KU and Global Green Growth Institute (GGGI)



Report Submission to Ministry of Energy about Green Hydrogen based Chemical Fertilizer in Nepal



MoU between KU and IPPAN for cooperation in Hydropower and Green Hydrogen



Discussion with Finance Minister on the Role of Green Hydrogen in Energy Transition of Nepal



Discussion on Green Hydrogen business opportunities with Mr. Shesh Ghale and Ms. Jamuna Gurung



Researchers at Green Hydrogen Lab in a meeting

GLOBAL POLITICAL COMMITTMENT



Australia

National Hydrogen Strategy, 2019



Canada

Hydrogen Strategy for Canada, 2020



Chile

Hydrogen Green Hydrogen Strategy, 2020



Czech Republic

Hydrogen Strategy, 2021



European Union

EU Hydrogen Strategy, 2020



France

Hydrogen Deployment plan, 2018
National Strategy for Decarbonized Hydrogen Deployment, 2020



Norway

Government Hydrogen Strategy, 2020
Hydrogen Roadmap, 2021



Germany

National Hydrogen Strategy, 2020



Hungary

National Hydrogen Strategy, 2021



Japan

Strategic Roadmap for Hydrogen and Fuel Cells, 2019
Green Growth Strategy, 2021



Korea

Hydrogen Economy Roadmap, 2019



Netherlands

National Climate Agreement, 2019
Government Strategy on Hydrogen, 2020



Portugal

National Hydrogen Strategy, 2020



Russia

Hydrogen Roadmap, 2020



Spain

National Hydrogen Roadmap, 2020



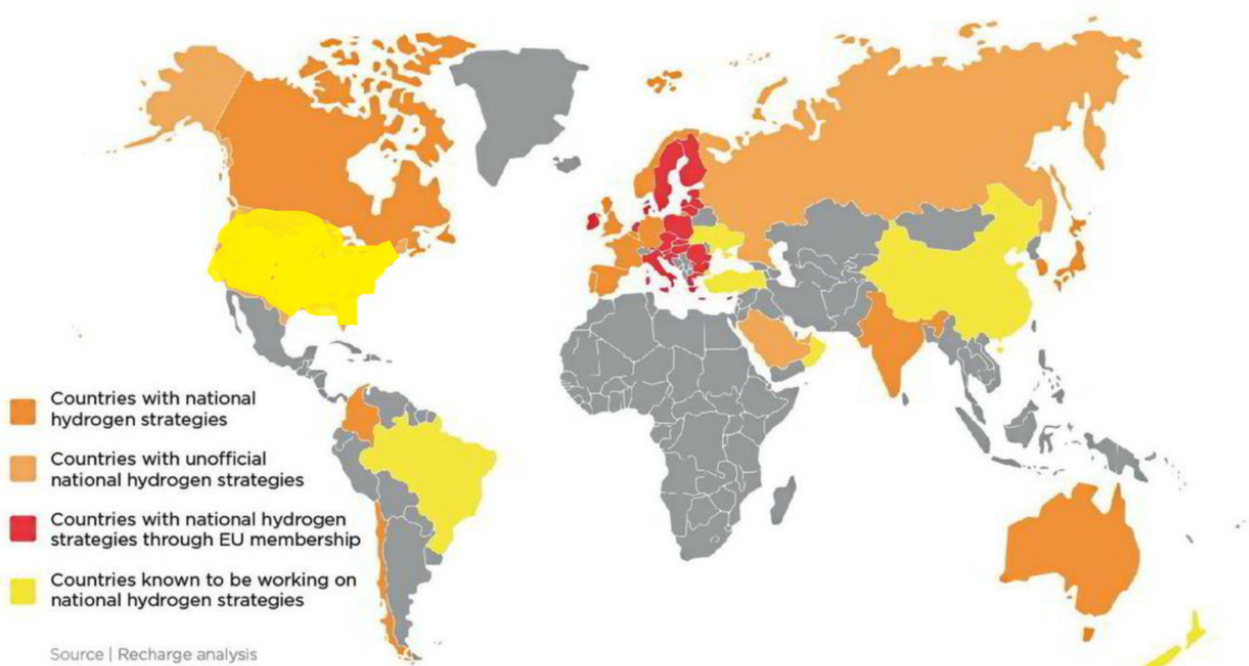
India

National Hydrogen Mission, 2022



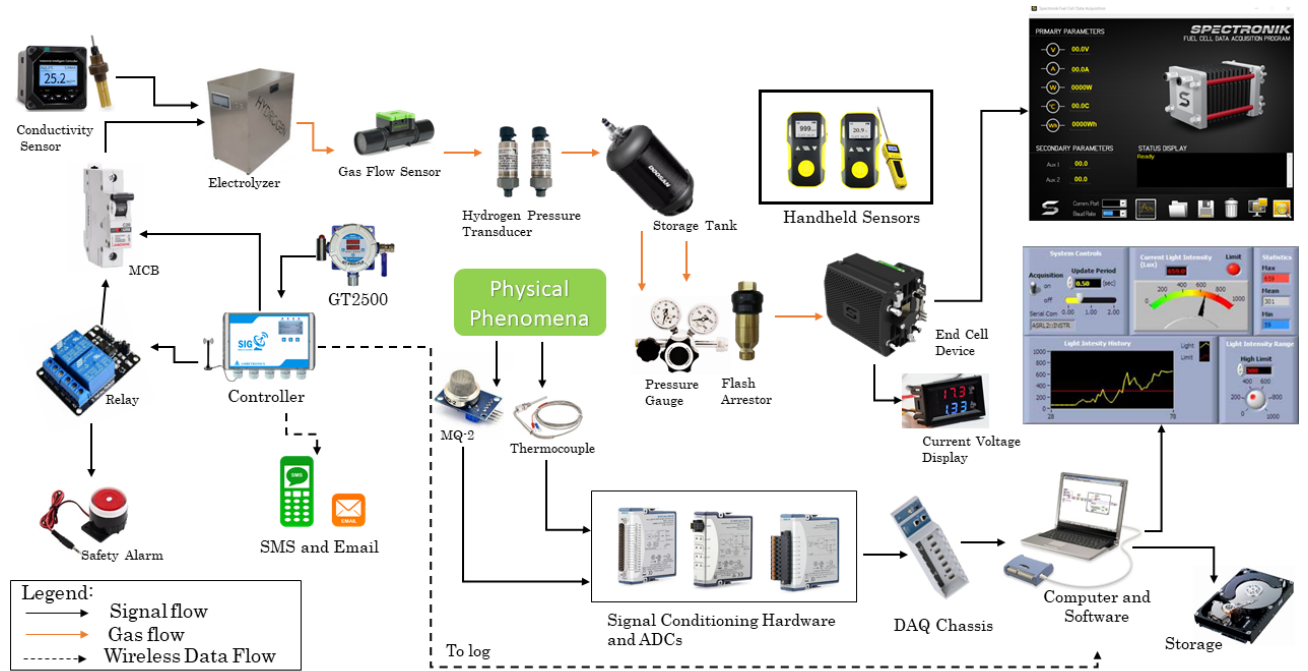
United Kingdom

UK Hydrogen Strategy, 2021

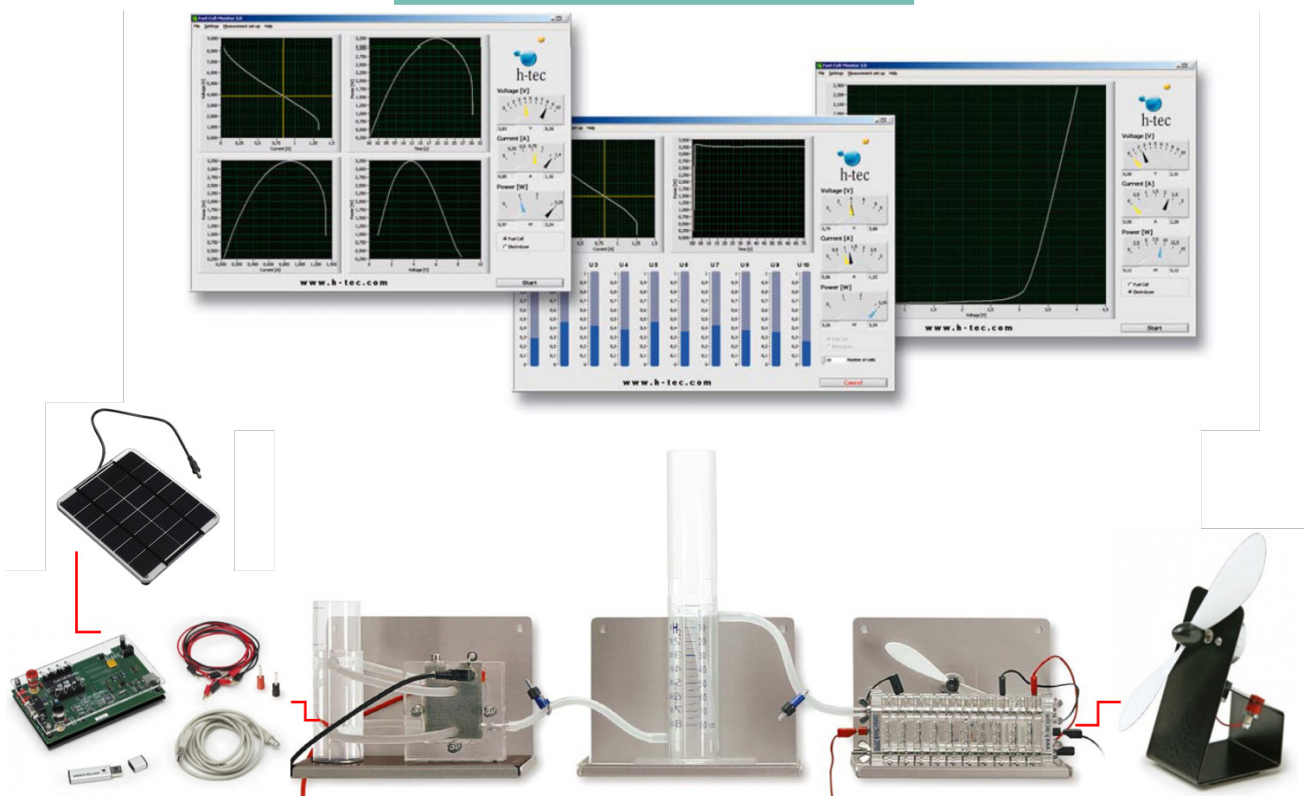


Global Hydrogen Roadmap

1kW HYDROGEN VALUE CHAIN



15W HYDROGEN VALUE CHAIN



OTHER COMPONENTS



Deionizer



Gas Booster Pump



PEM Electrolyzer



Hydrogen Purifier



Refilling System

The **Nepal Hydrogen Initiative (NHI)** is a consolidated program to establish the policy foundations, develop an implementation action plan, and incubate a value chain for the business development with Green Hydrogen as the driving force to address the existing and upcoming challenges of the environment, fuel, energy, economy, and industrial development in Nepal. At present, NHI is an entity of Kathmandu University and is conceived to be owned by Nepal Government in future.

Contributing to '**Carbon Neutral and Energy Independent Nepal**'.

Green Hydrogen for Ammonia Production.



Green Hydrogen for Industrial Heat.



Green Hydrogen for zero-emission Transportation.



Green Hydrogen for Re-electrification.



Green Hydrogen for Steel and Mining.



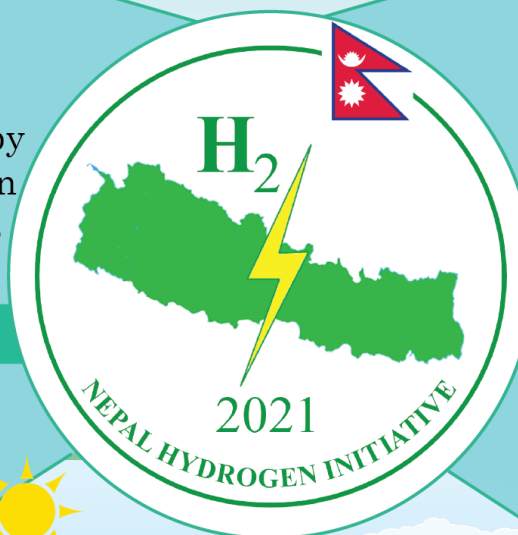
Mission

Reduction in fossil based fuel consumption and greenhouse gas emissions, and contribute to more secure and efficient industrial processes by enabling the commercialization of green hydrogen technologies in Nepal.

Vision

Transformation of Nepalese Economy and Society by enabling the sustainable and affordable Green Hydrogen Technologies from the available renewable energy resources.

Showcase Projects



Targets

Phase-I: 2021-2025: Inception phase



Phase-II: 2025-2030: Commercialization



Phase-III: 2030-2040: Global Presence



PROMOTERS



**GREEN
HYDROGEN
LAB**

CONTRIBUTORS



EnergizeNepal
Hydro Himalaya

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