

## **Sustainability Engineering: Determination of Water and Energy Footprints using Life Cycle Assessment**

### **Overview**

Sustainable engineering ensures the designing or operating systems to use energy and resources sustainably, in other words, at a rate that does not compromise the natural environment, or the ability of future generations to meet their own needs. Life cycle assessment (LCA) assesses all the components and environmental impacts associated with a product, process or activity during its lifetime. Energy, Carbon, Water and Waste (ECWW) footprints are determined using LCA. This methodology provides useful scientific data to assist industry/research with decision making. The material and energy input data with additional information can be used to determine greenhouse gas (GHG) footprint and other environmental impact of any proposed process and to compare with the current process. The participants will understand the concept of environmental indicators which can be applied for industry development in India.

Understanding and awareness of environmental impact assessment and the quality management is useful for future engineering students and professionals going to work nationally and globally. Environmental degradation reduction and decarbonisation in India will require advanced skills by local scientists and engineers. International standards, ISO 14001 (Environmental Management System), 14044 (Life Cycle Assessment) and 14046 (Water Footprint) are useful for any organization including the tools, techniques, software and resources. The world is changing at an unprecedented rate. The population and consumers are becoming aware and demanding environmental credentials of everyday products they are using.

In the last two decades, LCA research work by Australia's Commonwealth Scientific and Industrial Organization (CSIRO) in the minerals and energy domain has focused on metal production including ferro-metals, other base-metals and also some light metals, covering both hydrometallurgical and pyro-metallurgical routes. CSIRO has extensive expertise in the LCA of iron and steel making. Furthermore, CSIRO has track record for LCA studies for energy processing, power systems and on underground, open-cut, heap leaching, in-situ leaching mining methods and the extraction of iron ore, bauxite, copper, gold, nickel and uranium ores have also been investigated. The CSIRO's application of biocoke, bioanode, biopitch in aluminium metallurgy using LCA tools and techno-economic considerations will be explained to course participants.

The course will be delivered by internationally acclaimed scientist, consultant, academic, and practitioner with proven knowledge, experience, and demonstrable ability in teaching, consultancy, research, and training in the field of life cycle assessment and engineering technology evaluation principles. The main resource person of this proposed course and his collaborators have been the pioneer in applying life cycle assessment techniques for multiple industry sectors and claimed to be globally first to apply life-cycle based water footprinting techniques for mining industries. They have contributed to the development of various international databases and they were the expert reviewers for quality control of data in such databases to be used in proprietary software for day-to-day LCA practitioners.

The foreign faculty of the course- Dr. Nawshad Haque, a Principal Scientist of Commonwealth Scientific and Industrial Research Organization (CSIRO), and Academic Adjunct (Monash, Swinburne and RMIT University) in Australia will deliver the contents of this course. Dr. Haque is the leader of CSIRO's LCA and techno-economic evaluation team in Mineral Resources and Energy Business Unit and currently leading hydrogen energy systems research. He works on process flow sheet modelling, economic and environmental evaluation of process systems for energy, mining, mineral processing and metal making industries using various tools, databases and software. He has demonstrated his technical knowledge, experience, and ability in research, consultancy, training and teaching. The course is planned and offered as per the norms set by GIAN and Motilal Nehru National Institute of Technology Allahabad (India).

### **Course Objectives**

This short course will provide participants opportunities to familiarise with various principles, concepts, methods, tools and software about environmental impact of processes and engineering products using life cycle assessment techniques. Participants will learn to design and analyse a wide range of engineering technologies, processes and products applicable for various industry sectors. After successful completion of this short course, participants will be able to:



- Understand the basic life cycle assessment techniques applicable for choosing technologies and engineering materials for various applications;
- Identify key contributors for energy, water, carbon and waste footprints for improving efficiencies;
- Develop new ideas and logical explanation;
- Design scenarios and assessment techniques for the evaluation of technologies, engineering processes and products.
- Develop an understanding of life cycle engineering and focuses on recycling of engineering materials and products at their end of life.

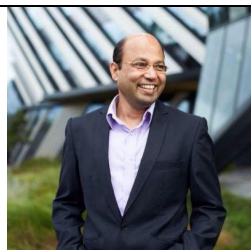
<b>Dates</b>	<b>26-31 December 2022</b>	
<b>Location</b>	<b>The course will be conducted via offline mode at the Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj-211004, U.P. (India).</b>	
<b>Course Schedule</b>	26 <sup>th</sup> Dec. 2022 (Monday)	<b>Inauguration: 9.00 AM-9.30 AM</b> <b>Lecture Module 1 &amp; 2: 10:00 to 11:00 AM (1 hr)</b> Topic: Introduction to Life Cycle Assessment (LCA). What is LCA and why it is necessary for Engineering professionals? <b>Lecture Module 3 &amp; 4: 11:15 to 12:15 PM (1 hr)</b> Topic: Doing an LCA, Guidance for life cycle assessment, Overview of International Standards ISO 14044 (2006), four major stages or steps of LCA, other relevant guidelines, environmental impact categories in LCA. <b>Hands-on Session/Tutorial 1 : 12.30 to 1.30 PM (1 hr)</b> Topic: Introduction to Sustainability software to carry out LCA in Practical/Industrial Problems through Case study.
	27 <sup>th</sup> Dec. 2022 (Tuesday)	<b>Lecture Module 5 - 8: 9:30 to 11:30 AM (2 hrs)</b> <b>Topic:</b> Introduction to Life cycle assessment software- SimaPro, GaBi, and OpenLCA. <b>Lecture Module 9 &amp; 10: 11:45 AM to 12:45 PM (1 hr)</b> <b>Topic:</b> LCA databases- Ecolnvent, US LCI, ELCD, AusLCI, Indian LCI databases, Data quality considerations, what is involved in carrying out an LCA? <b>Hands-on Session/Tutorial 2 &amp; 3: 2.30 to 4.30 PM (2 hrs)</b> <b>Topic:</b> Practice and Problem solving using the SimaPro LCA Software through Case study.
	28 <sup>th</sup> Dec. 2022 (Wednesday)	<b>Lecture Module 11-12: 9:30 to 10:30 AM (1 hr)</b> <b>Topic:</b> Introducing example system, data collection templates for input in LCA software, inputting data into LCA software, the structure of an LCA model, performing a calculation, basic procedures behind the calculation. <b>Lecture Module 13- 15: 10:45 to 12:15PM (1 hr)</b> <b>Topic:</b> What to expect from the basic results, inventory and impact categories and assessment, contributions analysis, sensitivity and Monte Carlo analysis? Interpreting the results, what do they mean? What are the implications and strength of LCA studies? Limitations of an LCA. <b>Hands-on Session/Tutorial 4 - 5: 12.30 to 1.30 PM (1 hr) + 2.30 to 3.30 PM (1 hr)</b> <b>Topic:</b> Practice and Problem solving using LCA Software: Data input, Calculation, Monte-Carlo Analysis through Case study.
	29 <sup>th</sup> Dec. 2022 (Thursday)	<b>Lecture Module 16 - 17: 9:30 to 10:30 AM (1 hr)</b> <b>Topic:</b> Sustainability in resources industries, energy, mining and mineral processing, sustainability in the context of metal production, recycling of materials, E-waste processing issues. <b>Lecture Module 18 -19: 10:45 to 11:45 AM (1 hr)</b> <b>Topic:</b> How LCA can be used in case studies- open-cut, underground,



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		in-situ leaching mining method, iron ore, copper ore, and bauxite processing. <b>Lecture Module 20: 12:00 Noon to 12:30 PM (0.5 hr)</b> <b>Topic:</b> LCA for steel making and steel industry, ferroalloys, LCA for gold production, aluminium and comparison of production using various energy sources. <b>Hands-on Session/Tutorial 6-7: 12.30 to 1.30 PM (1 hr) + 2.30 to 3.30 PM (1 hr)</b> <b>Topic:</b> Undertaking LCA of an example product using SimaPro: Part-1 & 2 through Case study.								
	30 <sup>th</sup> Dec.2022 (Friday)	<b>Lecture Module 21 -22: 9:30 to 10:30 AM (1 hr)</b> <b>Topic:</b> LCA of various energy systems (coal-based electricity, gas powered power plants, nuclear, solar, wind, hydro).  <b>Lecture Module 23- 24:10:45 to 11:15 AM (1 hr)</b> <b>Topic:</b> Introduction to water management and ISO 14046 for life cycle-based water footprint determination and concept of embodied water of products.  <b>Lecture Module 25- 26:12 Noon to 1 PM (1 hr)</b> <b>Topic:</b> Introduction to ISO 14001 Environmental Management System (EMS), benefits, procedures and guidelines on how to develop EMS documents according to ISO. What is PDCA in the context of EMS?  <b>Hands-on Session/Tutorial 8: 2.00 Noon to 5.00 PM (3hrs)</b> <b>Topic:</b> Tour of a Process/Power plant.								
	31 <sup>st</sup> Dec.2022 (Saturday)	Evaluation of Learning Outcomes (Examination/Test, Feedback) & Certificate distribution. 9.30 AM-12 Noon.								
Who should attend?	<ul style="list-style-type: none"><li>• Anyone with a degree in Civil, Chemical, Environmental, Mechanical or relevant branches of Engineering and Science.</li><li>• Student at all levels (B.Tech./B.Eng./B.Sc./M.Sc./MTech./Ph.D.) and faculty members/academic staff from universities and institutions.</li><li>• Engineers, Scientists and Professionals working in companies, industries and R&amp;D institutions.</li></ul>									
Course Fee	<p><b>One-Time GIAN Registration:</b> Please visit <a href="http://www.gian.iitkgp.ac.in/GREGN/">http://www.gian.iitkgp.ac.in/GREGN/</a> and register by paying Rs. 500/- (who have already been paid, need not pay again).</p> <p>The participation fees for attending the course is as follows:</p> <table><tr><td><b>Participants from abroad:</b></td><td>US\$ 200 + 18% GST</td></tr><tr><td><b>Industry/ Research Organizations:</b></td><td>Rs. 5000 + 18% GST</td></tr><tr><td><b>Academic Institutions (Faculty members):</b></td><td>Rs. 3000 + 18% GST</td></tr><tr><td><b>Academic Institutions (Students/Research scholars):</b></td><td>Rs. 1000 + 18% GST</td></tr></table> <ul style="list-style-type: none"><li>• The course will be offered via OFFLINE mode.</li><li>• No hardcopy of the learning materials would be provided to the participants.</li><li>• Minimum 90% attendance necessary to be eligible for certificate of participation/attendance.</li><li>• Appearing for evaluations/examinations during the course is necessary for certificate of grades in the course.</li></ul>		<b>Participants from abroad:</b>	US\$ 200 + 18% GST	<b>Industry/ Research Organizations:</b>	Rs. 5000 + 18% GST	<b>Academic Institutions (Faculty members):</b>	Rs. 3000 + 18% GST	<b>Academic Institutions (Students/Research scholars):</b>	Rs. 1000 + 18% GST
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<b>Academic Institutions (Students/Research scholars):</b>	Rs. 1000 + 18% GST									
Bank Details	<p><b>Account Name:</b> Non Formal Continuing of Edu. <b>Account No.:</b> 10424975574. <b>Bank Name:</b> State Bank of India (SBI). <b>Branch:</b> MNNIT Allahabad, Prayagraj-211004, Uttar Pradesh, India. <b>IFSC Code:</b> SBIN0002580. <b>Last Date of Registration:</b> 8<sup>th</sup> Dec. 2022.</p>									

## International Expert



### Dr. Nawshad Haque, CSIRO, Australia

Dr. Nawshad Haque is a Principal Scientist and Research Team Leader of Commonwealth Scientific and Industrial Research Organization's (CSIRO) life cycle assessment (LCA) and techno-economic evaluation and hydrogen energy systems team in Mineral Resources and Energy Business Unit in Australia. His current focus now as a project Leader to develop techno-economic and environmental modeling tools using LCA for future multibillion dollars hydrogen energy systems in Australia. He works on process modeling, economic and environmental evaluation of process systems for mining, mineral processing & metal making industries using various tools, databases and s/w.

Dr. Haque has extensively studied LCA of a variety of metals, including aluminium, magnesium, ferroalloy, gold and nickel to identify opportunities for CO<sub>2</sub> emission reduction. He has also evaluated projects such as energy systems, biomass-derived charcoal application in steel making with fossil coal blends to reduce environmental impact and the application for biocoke, bioanode, biopitch in aluminium production using LCA tools and techno-economic considerations. These studies have led to numerous publications, some of which have been used internally in CSIRO and by various external industry groups. Dr. Haque has developed over 10 software tools for drying industry applications.

Dr. Haque commenced work as a materials scientist at New Zealand Forest Research Institute and in 2005 joined CSIRO. Dr Haque has been awarded a Ph.D. in Chemical Engineering from The University of Sydney, Australia in 2002. Dr Haque is an elected Fellow of the Australasian Institute of Mining and Metallurgy, Australian Institute of Energy, and The Institute of Materials, Minerals and Mining (IOM3) UK. He was a Professional Engineer accredited by the Engineers Australia, a member of The Minerals, Materials and Metals Society (TMS) US, and a Director of the Board of the Australian Life Cycle Assessment Society.

Dr. Haque, being an Adjunct Faculty, coordinates undergraduate courses on mineral processing at Monash University Australia, sustainability and life cycle assessment at Swinburne University Australia, offers lectures at RMIT University and run workshops over a decade and co-supervised 11 Ph.D. students and 54 vacation scholarship projects to completion. Currently he supervises four Ph.D. students at various Australian universities. Dr. Haque has published over 100 publications to various refereed journals and conferences.

He manages several high level inter-governmental scientific collaborations and is the Leader for the MoU signing between large multiple research organizations, government science agencies, ministries and universities. For more information in LinkedIn: <https://www.linkedin.com/in/nawshad-haque-9b79381/>

## Host Faculty:



**Dr. Akshoy Ranjan Paul** is an Associate Professor in the Department of Applied Mechanics, Motilal Nehru National Institute of Technology Allahabad (India). Dr. Paul has over 20 years of teaching and research experience and is actively involved in research in the areas of fluid mechanics, turbomachinery, CFD and green energy. He obtained his Ph.D. from MNNIT Allahabad in 2013. Dr. Paul has published over 200 research papers, 4 textbooks and delivered several invited talks in India and abroad on a variety of technical and motivational topics. Dr. Paul is presently working in several research projects sponsored by various government agencies as an investigator.



**Dr. Anuj Jain** is a Professor (HAG) in the Department of Applied Mechanics, Motilal Nehru National Institute of Technology Allahabad (India). He served as Dean (Research & Consultancy) during 2010-12, as Head, Department of Applied Mechanics during 2013-15 and as Head, Department of Chemical Engineering during 2016-17. Prof. Jain has obtained his Ph.D. degree on heat recovery through cyclone separator from IIT Roorkee. He has more than 35 years of teaching and research experience. He has published over 175 research articles. Besides, he has co-authored one textbook on Strength of Materials for undergraduate level students. Eight students have been

awarded Ph.D. degree under his guidance so far. He has supervised 85 M. Tech. theses. Prof. Jain has completed two externally funded research projects on bio-fluid flows as the principal investigator. His current research interests include application of CFD for various challenging problems. Prof. Jain was the Chair of 6th International & 43rd National Conference on Fluid Mechanics and Fluid Power (FMFP-2016) and is the Vice-President of the National Society of Fluid Mechanics and Fluid Power, India.



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**Contact:**

Principal Course Coordinator	Course Coordinator	Local GIAN Coordinator
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