IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Techno-economic modelling of green steel production**	
Project Number	**IMURA1095**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Artificial Intelligence and Advanced Computational Modelling*
2	*Circular Economy*
3	*Clean Energy*
4	*Health Sciences*
5	*Smart Materials*
6	*Sustainable Societies*
7	*Infrastructure*

The research problem

Define the problem

Global demand for steel is expected to grow by 30% by 2050, during which time India is projected to overtake China as the world's largest steel producer and consumer. Over the same period, the world seeks to reduce its global carbon emissions to net zero. This presents a significant challenge, as steel is currently responsible for around 7% of global emissions. While some emissions reduction will be achieved by increased use of recycled materials, due to increased demand it is expected that in 2050 over 50% of global steel demand will still be met by virgin steel produced from iron ore. Approximately 1.9 Tonnes of CO_2 is emitted for every tonne of steel produced using conventional means. However, steel's emissions intensity can be drastically reduced, if not eliminated, through the production of "green steel" - steel generated from iron ore using renewable energy sources.

Navigating the transition to a green steel economy presents a significant challenge for both India as the future leader in steel production and Australia as the world's largest producer of iron ore. There are several key factors that will influence the trade in green steel and related commodities between the two countries: the manner and locations in which the steel and its precursors are produced; the type and quality of the iron ore used; and the local availability of renewable power.

This project seeks to model the production and trade of green steel and its related commodities between Australia and India, and develop economic tools to help inform both industry and government to understand the challenges and identify opportunities associated with different development options.

Project aims

Define the aims of the project

This project seeks to characterize the production and trade in Green Steel and related commodities between Australia and India, and in so doing develop tools to help policy makers and investors in both countries navigate this transition.
The project aims to:

- Assess the impact of different ores, impurities and production methods on the costs of green steel.
- Model the effects of different production pathways and locations on the trade in green steel and related commodities.
- Evaluate the impact of international fiscal policies and incentives on green steel economics.

What is expected of the student when at IITB and when at Monash?

Highlight how the project will gain from the students stay at IITB and at Monash

IITB the student will assess the effects of different production methods on the efficiencies and costs associated with green steel production from various ore-precursors under different production methods (e.g. Reduction by hydrogen, ammonia).

At Monash, the student will use these findings to develop a techno-economic model that assesses the potential costs of various production routes between the two countries.

Expected outcomes

Highlight the expected outcomes of the project

- Understanding of the effects of different green steel production pathways and precursor iron ores on the costs of green steel production

- A techno-economic model that accounts for these factors on the trade in green steel and related commodities between Australia and India.
- Case studies comparing potential pathways for production of green steel between the two countries.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

Clean energy:
The project directly deals with the decarbonization of the steel industry - one of the “hard to abate” sectors of the energy economy.

Infrastructure:
The project will include assessments of the availability of local power, water and transportation infrastructure to support the development of this new industry.

Potential RPCs from IITB and Monash

Provide names of the potential research progress committee members (RPCs) and describe why they are most suited for the proposed project

Prof. Srinivas Seethamraju (IITB) – Prof. S. Seethamraju is a professor at the Energy Science and Engineering department at IITB. His background is in the chemical engineering and his research interests are integration of renewal energy and waste to energy.
Prof. Sanjay Chandra (IITB) – Prof. Chandra is a currently a professor of practice at Metallurgical Engineering and Materials science department at IITB. He has spent about 37 years at Tata Steel, India in various capacities including the Chief R&D.

Dr. Tom Hughes (Monash) – Dr. Hughes is the head of the Monash Hydrogen Research Node. He has a background in chemical engineering with expertise in the transport and production of hydrogen.
Dr. Roger Dargaville (Monash) – Dr Dargaville is a member of the Resources Engineering group, with research expertise in large-scale renewable energy system integration and optimization.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

- Master’s degree in Energy science or chemical engineering or equivalent

- Experience in Python and or Matlab will be required for this project. Previous experience with ArcGIS or similar software would be advisable, but not necessary.

Necessary Courses

Name three tentative courses relevant to the project that the student should complete during his/her coursework at IITB (the student will require to secure 8 point in these courses)

1. SOM 602 Microeconomics or SOM 607 Macroeconomics
2. EN 606 Energy resources, economics and environment
3. EN 301 Introduction to renewable energy technologies

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Potential collaborators: JSW steel Ltd.

At Monash potential collaborators can be found throughout the Monash – Woodside Energy Partnership and the Monash Hydrogen Research Node.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Green Chemistry and Renewable Energy 18
Metallurgy 33
Geoscience, geotechnical, geomechanics 7