

An Indian-Australian research partnership

**Project Title:** **Experimental and modelling studies on Plastic-Biomass co-gasification for decentralised waste management**

**Project Number** **IMURA0946**

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### Research Clusters:

### Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? <i>(Please nominate JUST <u>one</u>. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>		Highlight which of the Academy's Theme(s) this project will address? <i>(Feel free to nominate more than one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>	
1	Material Science/Engineering (including Nano, Metallurgy)	1	Advanced computational engineering, simulation and manufacture
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Infrastructure Engineering
3	Math, CFD, Modelling, Manufacturing	3	Clean Energy
4	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	4	Water
5	Earth Sciences and Civil Engineering (Geo, Water, Climate)	5	Nanotechnology
6	Bio, Stem Cells, Bio Chem, Pharma, Food	6	Biotechnology and Stem Cell Research
7	Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng	7	Humanities and social sciences
8	HSS, Design, Management	8	Design

## The research problem

The municipal corporations have limited reach to population, often to big cities and urban landscape. There are more than 6 lakh villages in India and no or limited access to any waste management or recycling technologies. With changing lifestyle and use of farm machinery, rural areas are facing issues of plastic litter and agro residues being burnt in farms. The transportation cost of waste from dispersed rural landscape to urban centric waste management or recycling facilities is a major inhibitor for technologies access to masses. There is a need to develop a technologically and economically feasible decentralised model of waste management that could reach to the mass.

Packed Bed Gasification process is one of the 'waste to energy conversion' technologies which has potential to address this issue. Gasification is a mature technology which converts solid carbonaceous waste to gaseous fuel. Packed bed downdraft gasification system yields very low tar and the product gas is good to power IC Engines and generate power or can be used for thermal application. Packed bed Downdraft Gasification technology is apt for small to medium scale applications with feed varying from 1 kg/h to few tonnes per hour, very much suitable for decentralised operations. The electricity generated from the Gasification systems can be fed to grid or used locally, thus enhancing its economic viability as well.

Biomass and coal gasification processes are mature and readily available technologies. Plastic is also carbonaceous in nature but is not suitable for the packed bed gasification process alone. Residual char is a crucial component for the efficient gasification process and energy rich CO & H<sub>2</sub> production in gasifier. Plastic yields very little char (4-11%), unlike biomass which yield 10- 20% as char. Also, the homogenous nature of plastic constituent and lack of oxygen in most of the plastics, unlike heterogenous biomass, the pyrolysis behaviour and oxidiser requirements are also different from the biomass under similar temperature and heating rates. But, the co-gasification of plastic-biomass (agro residue) has the potential to produce a high-quality synthesis gas for decentralised power generation.

## Project aims

The Overall aim of the project is to develop a decentralised gasification system for effective processing of plastic and agro-residue waste diverting these away from landfill and produce power at the same time.

## Expected outcomes

The expected outcomes are:

- Fundamental pyrolysis and gasification kinetics of biomass-plastics feedstock
- Process development for plastic-biomass fuel preparation suitable for the gasification system
- Evaluation performance through fundamental studies (Single particle analysis) on the behaviour of thermal decomposition and pyrolysis of biomass-plastic mix pellets in reactive environment
- Experimental studies on a packed bed downdraft gasification system with plastic-biomass mixed feed to develop process parameters (Air-Fuel ratio and air mass flux) for low tar and sustained operation
- CFD based modelling studies at single particle and packed bed level to develop better understanding of the effect of process parameters on the gasifier performance and efficiency
- Techno-economic study to evaluate feasibility of the system in rural setup for given types of crop residue and plastic waste for power generation

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

Clean Energy – The proposed project aims at clean electricity generation using waste like plastics and agro-residue. The proposed Gasification process is a carbon neutral technology. Apart from clean energy production, the project focuses on development of a decentralised waste management system which will have major impact on public health and local environment. This will also contribute towards generation of local employment.

## 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.*

The candidate should have a degree in Engineering – Chemical or Mechanical or a degree in Chemistry. Some familiarity with computational fluid dynamics will be an advantage.

## Potential Collaborators

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

Organisations involved in developing solutions for waste processing – both in India and Australia