

A cost-effective and efficient green hydrogen production unit operational with wastewater

Funding Requirement INR- 90L over 2 years

### **Objective**

- 1. Provide an energy-efficient green H2 production technology
- 2. Use of wastewater during catalysis
- 3. Use of a robust and inexpensive material for bifunctional water-splitting

### Impact

- 1. Developing cheap catalysts to drive the water oxidation reaction in the alkaline media
- 2. Developing an alternative, carbon footprint-free energy resource
- 3. Establishing the framework of a parallel hydrogen economy
- 4. Integrating renewable energy resources (such as solar or wind energy) in hydrogen generation

### **Project Description**

The long-term durability, challenging manufacturing procedure, moderate to poor reactivity, and synthetic scalability have posed serious questions on the realistic applications of existing materials for designing real-life electrolyzers. Therefore, there is a serious need for the development of bifunctional catalysts that can initiate an overall water-splitting reaction generating green hydrogen for future energy applications.

### **Principal Investigator**



#### Prof. Arnab Dutta,

Associate Professor, Chemistry and Interdisciplinary Programme in Climate Studies Email: arnab.dutta@iitb.ac.in

## **Co-Principal Investigator**



**Prof. Vikram Vishal** Associate Professor, Earth Sciences and Interdisciplinary Programme in Climate Studies Email: v.vishal@iitb.ac.in



### **Contact Us**





Low cost and energy efficient hydraulic structures and solutions for water distribution systems for rural and urban areas

### Objective

- To study the existing challenges in urban water supply systems (WSSs)
- To develop phase-wise plan of improvement in the WSS
- To demonstrate low-cost hydraulic isolation technology

#### Impact

- Improving the performance of the water supply infrastructure in both rural and urban areas
- Reducing water losses, saving financial and other resources in maintaining the water distribution system

### **Project Description**

Most Water Supply Schemes (WSSs) are typically designed for 24x7 operation in India. The designs are based on rigorous surveys and primary data collection, and entire WSSs are designed and simulated using hydraulic modeling software. However, the operation of WSS in India is based on Intermittent Water Supply (IWS). Operators tend to divide the systems into small zones and try to smoothen the resistances of consumers by increasing the pressure in the systems by creating unified diversions of flow to a particular area. The gap between the design and actual operation of WSS results in numerous issues. The deterioration of water supply infrastructure, increased leakage, declined water quality, and inequitable supply are the significant ill effects of IWS.

Funding Requirement INR- 50L over 1 year



### **Principal Investigator**

Prof. Pradip Kalbar,

Associate Professor, Centre for Urban Science and Engineering (CUSE) Email: kalbar@iitb.ac.in



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Real-time irrigation water management with weather forecasts and soil monitoring to enhance crop production

Funding Requirement **INR-1.50 Cr** over 3 years

### **Objective**

- 1. Agricultural monitoring using muti-sourced data
- 2. Regional weather modeling
- 3. Farm scale ecohydrological Modeling
- 4. Participatory Framework working with the farmers
- 5. Development of tools and apps for farmers

#### Impact

- 1. Irrigation water advisory for the farmers
- 2. Solution for water and food security
- 3. Improving the farmers' wellbeing with a better yield
- 4. Meeting the "more crop per drop" objective

#### **Project Description**

With the increasing population and the needed agricultural intensification, the water demand has increased considerably. Increased irrigation to meet the demand resulted groundwater depletion but did not result into per capita improvement of food production. The researchers at IIT Bombay have developed solutions to save water and improve crop yield with agricultural monitoring and climate smart water management.

### **Principal Investigator**



**Prof Subimal Ghosh**, Institute Chair Professor, Department of Civil Engineering, Email: subimal.ghosh@gmail.com



### **Co-Principal Investigator**



Visiting Faculty, Interdisciplinary Programme in Climate Studies Email: mahatma@umd.edu



Karthikeyan Lanka Assistant Professor, Centre of Studies in Resources Engineering Email: karthikl@iitb.ac.in



### Subhankar Karmakar,

Professor, Environmental Science and Engineering Email: skarmakar@iitb.ac.in





**Corporate Coordinator** 

Nishant Maloo | nishant.maloo@acr.iitb.ac.in

Dean Alumni and Corporate Relations Office, IIT Bombay





Impact of climate change on water availability and developing adaptation options for Mumbai's Metropolitan Region (MMR)

### Objective

- To identify relevant stakeholder groups and elicit their preferences on adaptation options.
- To develop a crowd sourcing app to increase awareness of water issues in MMR.
- To set up a hydrologic model simulating inflows to reservoirs servicing MMR.
- To obtain climate projections for MMR upto 2100 using adequate machine learning techniques.
- To identify feasible adaptation pathways to secure MMR's continued growth, share modeling results with stakeholders and communicate climate risk to the water supply of MMR.

#### Impact

Currently, there are no integrated modeling based assessments of MMR's water supply that consider (i) climate change, (ii) preferences of multiple stakeholders, (iii) potential regional conflicts with water uses for irrigation and hydroelectricity production, and (iv) are co produced with the multitude of stakeholders involved. Through this project, we attempt to provide a comparative analysis of adaptation pathways to secure MMR's future growth.

Funding Requirement INR- 30L over 3 years

### **Project Description**

We propose a stakeholder driven decision analytic framework to identify adaptation pathways that would secure MMR's water supply considering economic, equity and sustainability measures. The preferences of multiple stakeholders within and outside MMR region representing multiple sectors of industry, domestic water supply, hydroelectricity, and irrigation will be considered. A spatially explicit systems model would simulate natural hydrology in upstream source areas as well as hydrologic fluxes through existing infrastructure of reservoirs and supply pipelines considering reservoir operation policies. Both the systems model and adaptation options will be developed by iterative stakeholder elicitation and would enable a realistic identification of options.



### **Principal Investigator**

Prof. Riddhi Singh, Assistant Professor, Department of Civil Engineering, Email: riddhi@civil.iitb.ac.in



### **Co-Principal Investigator**

Prof. Pradeep Kalbar, Associate Professor, Centre for Urban Science and Engineering Email: kalbar@iitb.ac.in









JalTantra: A Web-Based Free-for-All Tool for Piped Water Network Design

Objective

- 1. Developing a freeware to plan and design the Water Supply System (WSS)
- 2. Integrating Geographical Information System (GIS) based demand allocation, data management and result visualization in the JalTantra
- 3. Development and implementation of Loop network optimization platform in JalTantra which is easy for the government engineers to use

#### Impact

- 1. Designing real-life water supply systems and contributing immensely in Jal Jeevan Mission.
- Widely used (userbase of about 200 organizations) across India. States such as Maharashtra, Rajasthan, West Bengal, Andhra Pradesh, Kerala, Haryana are using the application for designing real-lie water supply systems.

Funding Requirement INR- 50L over 3 years

### **Project Description**

The development of software to design WSS has emerged as a key research area. Most of the available freeware is getting obsolete, and the price of commercial software products is very high. JalTantra application developed at IIT Bombay is currently being used by the many state governments. However, funding support is needed to improve the existing tool.

### **Principal Investigator**



#### Prof. Om Damani,

Department of Computer Science and Engineering Email: damani@cse.iitb.ac.in



### **Co-Principal Investigator**

**Prof. Pradeep Kalbar,** Centre for Urban Science and Engineering Email: kalbar@iitb.ac.in



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### Autonomous, Retrofit Atomized Cutting Fluid (ACF) Delivery System for Sustainable Manufacturing

**Objective** 

The goal of this project is to enable the ACF technology for commercial applications in the manufacturing industry. Specific objectives of this project are listed below:

- To understand the effect of various atomization spray parameters such as droplet size, droplet velocity, spray impingement angle, spray impingement distance, etc., on the formation, flow, and heat transfer aspects of the cutting fluid film that penetrates the tool-workpiece interface during machining.
- To design the atomized spray system with a camera, temperature sensors, and closed-loop feedback to  $\bullet$ deliver optimal lubrication and cooling under all machining conditions.
- To develop and fabricate an autonomous ACF system prototype that can be retrofitted to any  $\bullet$ commercial CNC machining center.

#### Impact

The major outcome of this project will be the realization of low-cost, energy-efficient, and environmentallyfriendly machining processes via a significant reduction (20-50 times) in cutting fluid consumption from about 5-30L/hr (83-500 mL/min) to about 10-20 mL/min. The power requirements will be lowered by a factor of 10, while the associated cost will be reduced by 30%. More importantly, by minimizing the disposal of bacteria- and metal particulates-laden cutting fluid in the environment, the Indian manufacturing industry and the society at large will be propelled towards a sustainable and greener future.

#### **Project Description**

The goal of this project is to further develop the proven ACF technology for its broader adoption in the Indian manufacturing industry. This will be accomplished via the development of an autonomous, retrofit ACF system that fits onto any commercial machine. To achieve the objective, this proposal seeks to (1) develop a computational model of film formation, flow characteristics, and heat transfer aspects of the ACF delivery under various tool-workpiece geometries and machining conditions, (2) study the effect of different spray parameters such as droplet size, droplet velocity, spray impingement angle, spray impingement distance on the machining performance in terms of tool life and surface quality of the machined surface, and (3) design and fabricate an autonomous ACF system by the integration of vision and temperature sensors, spray actuators, and closed-loop control. The developed ACF delivery system with multiple sensors and closed-loop control will adjust its spray parameters in response to changing tool/workpiece geometries and machining conditions in order to deliver desired performance. Proof-ofconcept will be demonstrated by the integration of the prototype with existing commercial machining centers, i.e., turning, 3- axis milling machines, available at the Machine Tools Lab at IIT Bombay



### **Principal Investigator**

Prof. Soham Mujumdar,

Assistant Professor, Department of Mechanical Engineering Email: sohammujumdar@iitb.ac.in



#### **Contact Us**

**Corporate Coordinator** Nishant Maloo | nishant.maloo@acr.iitb.ac.in Dean Alumni and Corporate Relations Office, IIT Bombay



Funding

Requirement

INR-78 L over

3 years



**Probing Biocatalysts towards Degradation of Silicones** 

Funding Requirement INR- 75 L over 2 years

### Objective

- 1. Biodegradation of silicone polymer, or polydimethylsiloxane (PDMS) for the environmental benefits
- 2. Reducing the load on landfills

#### Impact

- 1. Reducing the environmental pollution due to incineration, and entombing silicones in a landfill
- 2. Waste to wealth generation

### **Project Description**

Initially, silicone polymers were treated as non-degradable in the environment, and for many years, they were considered to be inert to microorganisms. However, few recent studies showed the possibility of biodegradation of these polymers. The researchers at IIT Bombay are further working on examining the biocatalysts towards degradation of silicones.

### **Principal Investigator**



#### **Prof. Debabrata Maiti,** Associate Professor, Department of Chemistry

Email: dmaiti@chem.iitb.ac.in



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A research study on biodegradable silicones

Funding Requirement INR- 75 L over 2 years

### **Objective**

Reduce use of Non-Degradable polymers in manufacturing by substituting them with biodegradable polymers

#### Impact

Our society has become more and more dependent on non-degradable polymers like polyethylene due to its low cost of manufacturing and ease of use which has led to huge environmental problems like the plastic island in the middle of the pacific, land becoming barren across India or the constant threat to animals and animal ecosystem. Despite governments around the world trying to regulate the use of such polymers, there has been little success in reducing their use. The only way to reduce this dependency is to find and synthesize polymers which are biodegradable and cheap to manufacture which is something which we plan to achieve.

### **Project Description**

- 1. Degradation properties of potential polymers will be studied by studying their properties like changes in their physicochemical properties such as morphology, water uptake, weight loss, chemical composition and changes in molecular weigh using electron microscopy
- 2. Successfully tested polymers will be refined further and methods of synthesis developed



## **Principal Investigator**

Prof. Debabrata Maiti

Associate Professor, Department of Chemistry email:dmaiti@chem.iitb.ac.in



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Dissemination of Gasifier Based Community Cooking System and Biomass Fuel Processing Plant Funding Requirement INR- 30L over 2 years

### **Objective**

- 1. To Provide an environment friendly, cost-effective community cooking system in rural India
- 2. To convert hazardous agro-residue and biomass into sustainable fuel by using Gasification process
- 3. To make cooking fuel accessible and reduce dependency on LPG cylinders

#### Impact

Gasifier based community cooking and agro-residue palletization plant ensure the end-to-end social intervention in terms of the application of agro-residue utilization as fuel in Institutions/organizations. This technology will also enable replacement of traditional Chula's, where wood is used as a fuel and move towards more sustainable, environment friendly cost-effective methods.

### **Project Description**

Develop, design and implement palletization plants for Gasifier based community cooking system. Create a supply chain with the help of Farmer Produce Organizations (FPOs) and Self-Help Groups (SHGs) for dissemination of sustainable cooking fuel in rural areas of India.



### **Principal Investigator**

**Prof. Sanjay Mahajani** Professor, Department of Chemical Engineering Email: sanjaym@iitb.ac.in



### **Co-Principal Investigator**

#### **Prof. Sandeep Kumar** Assistant Professor, Department of Energy Science & Engineering Email: sandeep.kumar@iitb.ac.in



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#### **Contact Us**





Low-cost smart ultrasonic water meters for water conservation

Funding Requirement INR- 50L over 9 months

### Objective

- 1. To make, develop and deploy ultrasonic water meters for monitoring water consumption in residential localities and community toilets.
- 2. To conserve water by deploying the product in community toilets under SWACH Bharat Abhiyaan
- 3. To monitor and allocate drinking water and thereby save drinking water

#### Impact

- 1. Consumer accountability and equitable distribution of water
- 2. Reduction of non-revenue water (NRW) and wastage
- 3. Individual users, Communities, Water Supply Boards, Smart Cities to appropriately allocate and monitor water usage

### **Project Description**

A fully functional, IOT compatible, Ultrasonic Water Meter has been manufactured at IIT Bombay to monitor water consumption and wastage in the community. The product can be deployed at individual homes, apartment complexes, townships, water supply boards, municipalities, smart cities and community toilets to measure water usage.



### **Principal Investigator**



Email: nataraj@ee.iitb.ac.in



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Development of a Flood-risk Map for the Entire India: A Web-based Interactive Flood Information System.

### **Objective**

- 1. To develop Hazard Map utilizing global flood models.
- 2. To generate Socio-economic Vulnerability Map in a geospatial framework.
- 3. To derive the FRM by aggregating (1) and (2) at a national-scale.

#### Impact

Main deliverable will be a web-based (interactive) flood information system containing detailed flood-risk map (FRM) for the entire India, which is currently not available. The proposed FRM will mainly be beneficial to the many sectors but not limited to: Farmers, Irrigation Department, Urban Local Bodies (civic bodiesmunicipal corporations/councils), National Disaster Management Authority, Government of India.

1. Plausibly for the first time, it has been proposed to develop FRM for India at a national-scale, using multiple global flood models.

Funding Requirement INR- 2.5Cr over 2 years

2. An open access web-based flood information system will be developed for general-public, decision-makers and for all other stakeholders.

### **Project Description**

India has experienced a number of disastrous floods causing huge socio-economic losses mostly during the south-west and north-east monsoon induced by extreme rainfall and high tides. In such scenarios, a crucial non-structural measure is through developing a flood-risk map at watershed/national-scales. The past studies reported development of flood-risk map at national-scale for most of the developed countries, even in few emergent nations, like Bangladesh. Surprisingly, such efforts have never been conducted for India, which considered as a seventh-largest economy in the world. Hence, we propose to develop a comprehensive 'Flood-risk Map' for India accessible through a Web-based Flood Information System.



### **Principal Investigator**

Subhankar Karmakar

Professor and Head, ESED | Associate faculty, IDP in Climate Studies, IIT Bombay Email : skarmakar@iitb.ac.in



Co-Principal Investigator Subimal Ghosh Professor, Civil Engg. | Convener, IDP in Climate Studies, IIT Bombay



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#### **Contact Us**

Corporate Coordinator Nishant Maloo | nishant.maloo@acr.iitb.ac.in





#### Dean Alumni and Corporate Relations Office, IIT Bombay



A low cost solar-thermal-membrane water purification unit for brackish water treatment

Objective

- To develop a pilot portable solar-thermal-membrane unit for brackish water treatment.
- Deployment of pilot unit at Satpati village in Palghar Distt.
- To collect data and analyze the performance of the unit over a period of one year to assess performance and utilization in all weather conditions
- To develop the next generation of advanced water treatment system and analyze its performance using simulated water samples

#### Impact

Implementation of large scale WTP is difficult due to availability of large funds, lack of infrastructure, maintenance issues and access to remote areas. While some urban areas such as metropolitan cities have

Funding Requirement INR- 25L over 2 years

found much needed respite, smaller towns and villages still suffer at large. There is a need to develop novel solutions keeping in mind the smaller scale requirements which can be implemented at small scale (large households or small community levels) and in remote locations without much complexities. Local solutions will create a huge impact not only in terms of generating sustainable source of useable water but also on the economic and financial development of these areas. The proposed solution is not only simple to fabricate using locally available components, easy to maintain and repair and simple to operate. Further the proposed solution utilizes solar energy for purification which in principle can be implemented anywhere receiving sufficient sun time and is highly suitable especially for coastal regions. In absence of solar light the unit can still operate as a membrane based purification unit. This will provide significant respite to rural populations especially in the coastal belt, where brackish ground water is abundant. Furthermore the solution also provides at least 2 LPD high value pure distilled water in addition to the drinking water obtained from the plant.

#### **Project Description**

Access to safe water is the key to improved health and helps prevents the spread of infectious diseases. Utilization of existing water resources to produce useable water & provide local solutions and is economical. Unfortunately several regions especially along the coastal areas suffer from unavailability of useable water. Inadequate water transportation and infrastructure hinders growth and development of these places. These are however rich in brackish water sources. Thus, individual or small-community usable 'local' solutions can be used to provide respite rapidly. Here we propose development and deployment of a portable solar-thermal-membrane water purification equipment to produce useable water from brackish ground water.



### **Principal Investigator**

#### Prof. Sumit Saxena

Professor, Department of Metallurgical Engineering and Materials Science Email : sumit.saxena@iitb.ac.in



## **Co- Principal Investigator**

Prof. Shobha Shukla, Professor, MEMS, IITB



Dr. Jyotiraman De (PhD, MEMS)



Prof. V. K. Srivastava, PhD



### Contact Us





Carbon nanomaterial-based strips and an electronic controller for detection of mercury and arsenic species in natural water bodies.

**Objective** 

To develop a real-time monitoring sensor device for photocurrent/current based detection of mercury and dimethyl arsenate ion in natural water bodies. Cost-effective fabrication of sensor strips associated to sensor. Minimum water sample volume requirement-based setup.

#### Impact

A sensor device has been developed for photocurrent/current based detection of mercury and dimethyl arsenate ion in natural water bodies. R : Reference Strip S : Sample Strip Sensor strip for both Mercury (II) ion as well as Dimethyl Arsinate (V) ion detection has been fabricated using 0.1 mm thin patterned copper coated 9n FR4 substrate. Interdigited pattern channel length 0.5 mm x width 32 mm

#### **Project Description**

Water, the "origin promoter" for living species confronts ramification by poisonous environmental polluters. Challenges associated to heavy metal poisoning in environment has attained huge concern for its adverse impact on earth and life. Mercury contamination results in neural toxicity, insomnia, cognitive dysfunction, muscle atrophy, peripheral vision impairment and emotional instability to the human. The worldwide toxicity enlistments declare arsenic species as a leading pollutant categorized under group A carcinogenicity causing lethality in humans.

Funding Requirement INR-20 L over 2 years



### **Principal Investigator**

Prof. Shobha Shukla

Associate Professor, Department of Metallurgical Engineering & Materials Science Email: sshukla@iitb.ac.in

### **Co-Principal Investigator**

Rahul Kumar Das [PhD], Chandan Kumar [PhD], Sumit Saxena [PhD] & Shobha Shukla [PhD]



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Green development of technology for oil pollutants recovery from industrial wastewater

Funding Requirement INR- 15L over 2.5 years

### Objective

- To develop a 3D Graphene spongy material for separating hazardous oil spills from industries into waterbodies.
- To prevent ground-water from getting polluted with industry wastewater.

### Impact

- 1. Oil companies (ONGC, IOC, GAIL, HPC, Bharat Petroleum, Reliance Petroleum etc.) can use this technology and move towards green energy.
- 2. A well-balanced prosperous ecosystem of growth humans, industry and nature.

### **Project Description**

Oil-pollution is becoming one of the major environmental problems due to an unprecedented growth in the petroleum, food, textile, metal and leather industries. Oily wastewater discharge from industries is causing catastrophic effects on aquatic animals, flora and fauna and polluting groundwater. IITB aims to develop 3D graphene-based framework sponge and a device for separating and collecting oil from wastewater.



### **Principal Investigator**

#### Prof. Shobha Shukla

Associate Professor, Department of Metallurgical Engineering & Materials Science Email: sshukla@iitb.ac.in



### **Co-Principal Investigator**

#### Prof. Sumit Saxena Associate Professor, Department of Metallurgical Engineering & Materials Science Email: sumit.saxena@iitb.ac.in



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### Oil skimmer

Funding Requirement INR-20L over 2 years

### Objective

The objective is to develop a scaled up oil skimming device capable of skimming free and floating oil from water bodies.

#### Impact

A device has been developed which can skim oil from the water surface selectively, making it an effective tool for damage control and recovery of oil from the water surface, hence limiting the damage to the ecosystem. The device is equipped with GPS and battery power to work autonomously in remote and oil spilled regions along with a real time status updates. to the controller.

### **Project Description**

Oil spills in oceans due to accidents involving ships or drilling rigs and spills from oil pipelines into water

bodies create major havoc and extensive damage to the ecosystems. There is a requirement for a system where this floating oil can be skimmed and removed from the water surface.



### **Principal Investigator**

Prof. Shobha Shukla

Associate Professor, Department of Metallurgical Engineering & Materials Science Email: sshukla@iitb.ac.in



### **Co-Principal Investigator**

Prof. Sumit Sexana, Professor, MEMS,



Dharmveer Yadav (PhD, CRNTS)



Jyotiraman De (PhD, MEMS)



### **Contact Us**





**Rapid Water Quality Assessment of Rivers** 

Funding Requirement INR-25L over 3 years

### **Objective**

To build GIS inventory of water resources with respect to quality and develop framework for sampling for different rivers

#### Impact

The outcome of the study will help the government to assess the water quality of rivers frequently and rapidly at more sampling points cost effectively which in turn help to take precautionary and remedial measures against pollution and provide clean drinking water.

#### **Project Description**

Monitoring the river water quality frequently and at adequate points is a biggest challenge because of time consuming methods of sampling and testing



#### **Principal Investigator**

Prof. Bakul Rao Professor, Centre for Technology Alternatives for Rural Areas (CTARA) Email: bakulrao@iitb.ac.in



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### **Centre of Excellence in Smart Drone and Integrated Mobility Systems**

Funding Requirement INR- 1.50Cr over 5 years

### **Objective**

Intelligent automated ecosystem for smart trustworthy drones in integrated mobility systems for interconnecting things of the World

#### Impact

This proposed drone centre will be incubators of state-of-the-art applied research, development, and well positioned to offer tremendous and lasting benefits to all sectors of the economy and boost employment - in both India's urban and rural areas and aim to meet the government's vision of India becoming a Global Drone Hub by 2030.

### **Project Description**

Our vision of this centre seeks to address the lack of an effective drone ecosystem in India by creating a globally competitive facility, which provides leadership in through research, development, and industry collaboration.



### **Principal Investigator**

**Prof. Arnab Maity,** Associate Professor, Department of Aerospace Engineering Email: Arnab@aero.iitb.ac.in



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On wheel portable membrane based water purification system for disaster management.

### Objective

- Membrane based (UF and NF) prototype development
- Testing with different type of feed water
- New disinfection system testing
- Integration of sensors in online monitoring

#### Impact

The proposed system will able to easily provide 1000-10000 L in one hour depending on the scale. The energy for the system will be come form the inbuild generator and also can be easily integrate with the vehicle or the beat power. The proposed system will be compact and automated so can be easily operated and create less pollution as compared to bottled water. This will convert any wastewater/ contaminated water to drinkable water.

### **Project Description**

Funding Requirement INR- 25L over 1.5 years

Due to climate change extreme event are more frequent and lead to flood and also storm water problem in the cities. The proposed system will be compact and on wheel and able to easily mount on boat or vehicle, and will be easily move in to the affected area. This system will be based on membrane technology so will be compact and fully automatic so no human intervention required for the operation.



#### **Principal Investigator**

Dr. Swatantra Pratap Singh Associate Professor, Environmental Science and Engineering Department; CRNTS and Climate Studies, IIT Bombay Email : stallur@iitb.ac.in



### Co-Principal Investigator Mitil Koli Prime Ministers Research Fellow, Environmental Science and Engineering Department, IIT Bombay



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### **Reclamation of Foundry Sand**

Funding Requirement INR- 50L over 2 years

### **Objective**

- To deploy the technology developed by IITB for mechanical reclamation of waste green sand
- To deploy the technology developed by IITB for chemical reclamation of waste CO2 sand.

#### Impact

Implementation of the developed technologies would be an important step towards green foundries thereby reducing waste to a great extent. The unavailability of sand is also an important concern, which hampers the production. Reclamation would solve both the issues. Furthermore, it has a potential to reduce the sand mining significantly.

#### **Project Description**

India has more than 4000 small-to-medium scale foundries which use sand for metal casting to make moulds and cores. High temperature in the casting process results in damage of sand surface making it inappropriate to be used again. Huge amount of sand is dumped every day thereby adversely affecting the environment. Furthermore, it also results in ecological imbalance and illegal sand mining. IITB has developed technologies at pilot levels to reclaim two major sands- green and CO2 sand, and recycle back to the foundry. The technologies are at demonstration stage.



### **Principal Investigator**

**Prof. Sanjay Mahajani** Professor, Chemical Engineering Email: sanjaym@iitb.ac.in



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Team SHUNYA - Design and Demonstrate a Net Energy Positive, Net Zero Water, Net Zero Carbon House

Objective

- 1. Design, Construct, Operate and Demonstrate a single family dwelling unit with Zero or Positive Impact with a development of climate responsive methodology to replicate the project
- 2. Develop, study and demonstrate the recycled construction materials, Passive technologies, sustainable and smart housing technologies for renewable energy integration

| Impact<br>Impact Per<br>House &<br>Expected<br>Replicability<br>of Solution | Energy (Excess)= 5 MWh/YearCarbon Mitigation= 83 ton Eq. $CO_2/Year$ Water Saving= 2,04,765 liters/Year | 50<br>Years<br>of life |                                    |  |
|---|---|------------------------|------------------------------------|--|
|   | Agro Waste Recycled= 5.4 tonDurinSolid Waste Recycled= 16 tonConst                                      | g<br>ruction           | 5 Lakh +<br>Possible<br>Households |  |

### **Project Description**

- Project Vivaan is designed as a ray of hope for Market of Navi-Mumbai, a satellite city of Mumbai as a sustainable & smart solution to satisfy need of the local market replicable across developing cities of India
- Single Family Dwelling Unit of 100 sq.m for 4 to 6 members, constructed within 90 days of on site time
- Construction uses 80 % recycled locally sourced materials as agro waste, industry waste silica & plastic
- 10 kW solar rooftop with Li-ion Batteries with smart metering and appliance control generates 50 % excess electricity which provided to grid to mitigate carbon emission
- Water efficient fixtures, water recycling, rainwater harvesting, makes it IGBC Net Zero Water House
- Energy efficient centralized HVAC system with heat recovery, energy storage & smart controls for comfort

### **Principal Investigator**



## Prof. Venkata Santosh Kumar

Associate Professor, Department of Civil Engineering

#### Team

#### Faculty Advisors:

- 8 Faculty Advisors
- 5 Departments of IITB

#### Students:

- 50 + Students Members
- 10 + Research Students



teamshunya.com

Funding

Requirement

INR-1Cr



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Bioenergy-driven CO<sub>2</sub> capture and storage (BECCS)

Funding Requirement INR- 45L over 3 years

### Objective

In the BECCS there are two verticals are present

- CO<sub>2</sub> capture using biological species (mostly algae).
- CO<sub>2</sub> storage using different microbial organisms.

#### Impact

Bioenergy with carbon capture and storage (BECCS) is an alternative to fossil fuel energy and also a geoengineering technique that facilitates carbon dioxide  $(CO_2)$  removal from the atmosphere. More specifically, BECCS could be the only sustainable approach to achieve net "negative emission", which is a process to sequester more  $CO_2$  from the atmosphere than we emit. For eg. acquiring energy by burning down the sustainably grown biomass instead of coal and oil, and applying  $CO_2$  capture and storing (CCS) on the released  $CO_2$ .

### **Project Description**

Initial effort will be to understand the volume by volume (v/v) contribution of  $CO_2$  in the exhaust for that specific plant and then acquire knowledge of microbial ecology. Depleted hydrocarbon reservoirs have substantial  $CO_2$  storage potential. One of the long-term  $CO_2$  trapping mechanisms include  $CO_2$  enhanced oil recovery ( $CO_2$ -EOR). Microbial methanogenesis can convert around 13-19% of the injected  $CO_2$  to methane, which give rise to a sustainable carbon management technology without secondary pollution.



### **Principal Investigator**

**Dr. Arnab Dutta** Associate Professor, Chemistry and IDPCS Email: arnab.dutta@iitb.ac.in



### **Co-Principal Investigator**

**Dr. Vikram Vishal** 

Associate Professor, Earth Sciences and IDPCS Email: v.vishal@iitb.ac.in



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Cleaner and efficient biomass processing: Development of glucosetolerant, stable and efficient  $\beta$ -glucosidases for biofuel production

**Objective** 

On World Environment Day - 5 June 2021, the honourable Prime Minister of India, Mr Narendra Modi launched the E-100 pilot project in Pune. This project aims production and distribution of bioethanol across the country for achieving the target of 20% ethanol blending to petrol by 2025. The huge amount of biomass waste produced by India can be sustainably converted into bioethanol by such production plants using cellulases.

#### Impact

Due to the depletion of fossil fuel resources the demand for more environment-friendly alternative renewable fuels is growing. As a consequence, bioethanol produced from cellulose seems to be a potentially viable fuel. For the efficient and cost-effective production of bioethanol as biofuel, modifying the process of saccharification of cellulose to an industrial-scale process is crucial. Therefore, the proposed research project has tremendous national importance and social relevance as well as impact.

Funding Requirement INR- 50L over 2 years

### **Project Description**

We have developed two engineered glucose-tolerant and stable  $\beta$ -glucosidases. One of them (FoBgI) can even be engineered to create an enzyme suitable for functioning in the acidic conditions of fermentation. We will benchmark the properties of these enzymes from our laboratory with commercially available ones, improve thermostability (for their use at 55°C) and improve catalytic efficiency in the acidic pH range of 4.5-5.5.



### **Principal Investigator**

Prof. Prasenjit Bhaumik

Associate Professor, Biosciences and Bioengineering, IIT Bombay Email: pbhaumik@iitb.ac.in



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CO2 sequestration and valorisation through cyanobacterial technology

Funding Requirement INR- 55L over 2 years

### **Objective**

We have discovered a novel fast-growing cyanobacterium and have developed a genetic engineering toolbox for leveraging it to be a sustainable cell factory for the biosynthesis of value-added compounds and biofuel precursors. In this project, we propose an efficient cyanobacterial technology that will benefit the environment by removing unwanted carbon dioxide, and the engineered bacteria can also provide sustainable energy solutions without competing with our cropland.

#### Impact

Cyanobacteria, thrives on  $CO_2$  and converts it using nothing more than sun light into carbon and releases the leftover free oxygen in the atmosphere in a process we know as photosynthesis. Modern day plants are thought to have inherited the photosynthetic machinery from the cyanobacteria. Scientists are now investigating if this phenomenon can be scaled to not only capture enormous amounts of  $CO_2$  from the atmosphere but also to convert the carbon into valuable and useful resources such as hydrocarbons, biofuels and other biochemicals.

### **Project Description**

Preliminary results have already shown significant improvement in alkane production in the recombinant strain compared to the wild type. Further, changing the operonic arrangement, and external growth conditions can lead to a higher impact on the alkane synthesis in cyanobacteria. We also propose to create a background strain to divert maximum carbon flux towards alkane production. We plan to develop a commercially viable bioprocess in open ponds for alkane production using engineered cyanobacteria.



### **Principal Investigator**

#### Prof. Pramod Wangikar

Professor, Department of Chemical Engineering, IIT Bombay Email: wangikar@iitb.ac.in



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### Enhanced potato yield using Tuberonic Acid based novel approach

Funding Requirement INR- 45L over 1 year

### Objective

Tuberonic Acid (TA)-treated potato plants produced 2-fold more tubers when compared with the control (untreated) plants both at the greenhouse and field levels. Further, we also found that the tubers produced via our technology at the greenhouse level contained 10-fold more protein compared to the control. This has encouraged us to take the work further and test the effect of this GMO-free spent medium, containing TA, on other plants such as tomato, which belongs to the same family as that of potato.

#### Impact

Tuber initiation in potato plants is associated with a dramatic up regulation of TA, the plant hormone produced by conversion of jasmonic acid (JA) into 12-hydroxyjasmonic acid. We surmised that more tubers might be produced by the potato plants treated with more TA exogenously. Hitherto, the effect of TA, has not been studied or tested by anyone else. Thus, there are no relevant technologies being developed or being patented. We are keen to apply for a complete patent soon on our novel and innovative technology.

### **Project Description**

We were the first ones to identify a fungal enzyme, which directly converts JA into TA. We expressed this fungal enzyme in the smallest and fastest-growing surrogate plant called duckweed, assuming that it would naturally provide the substrate JA to the enzyme. Indeed, we were lucky that the transgenic duckweed not only produced enough amount of TA but also secreted it out into the spent medium. We used this GMO-free spent medium, which contained TA, to treat either leaves of soil-grown or roots of aeroponically grown potato plants.



### Principal Investigator

#### Prof. Rajesh Patkar

Associate Professor, Biosciences and Bioengineering, IIT Bombay Email: rajeshpatkar@iitb.ac.in



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Green technology development through algal farming as non-seasonal crop in rural India

Funding Requirement INR- 76L over 2 years

### Objective

This project will predominantly involve in situ optimization of algal cultivation with the local help. This will include, **Local survey:** identify potential sites for algal cultivation, educating the locals about immediate impacts of the project, **On site construction activities:** Small glass houses for algal cultivation, solar panels, water recycling plant. **Research activities:** Detailed below

#### Impact

Any abrupt or unknown variations due to global warming or pollution badly affect agriculture through product and productivity, ultimately leveraging entire agri-based market share. Therefore, one needs to think about sturdy, but sustainable variant for the same. Algal technology has been developed for more than three decades and practiced predominantly at research laboratories and industries for the production of various biochemicals. Despite years of research, only a few algae based products are slowly capturing the market.

### **Project Description**

We propose to development of photo-bioreactors in temperature-controlled glass houses, coupled with water recycling systems considering the targeted regions. Also, adaptive laboratory evolution (for dynamic light/ temp conditions) of the algal/ cyanobacterial strains in the glass houses, followed by incremental transition to the natural outdoor conditions. We will also determine specific products, devising the process for biomass isolation and storage before further industrial processing.



### **Principal Investigator**

**Prof. Pramod Wangikar** Professor, Chemical Engineering, IIT Bombay Email: wangikar@iitb.ac.in



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