Nextgen BioFuel

PILOT PROJECT

Standardised biofuel derived from any combination of input energy sources such as coal, sewage and lantana, etc using AI-controlled precision bio-fermentation.

Project Consortium

IIT Alumni Centre, MP

Srinivas Rachakonda

Life Fellow - Petroleum
Chairman - Prakriti Prerna Foundn.

Forum | PMU*

Dheeraj Rathi

Managing Director - Ecovis RKCA
Techno economic planning lead

Institute

Research Oversight

Distinguished Fellow : Carbon Sequestration
Distinguished Fellow: Ecohydrology
Distinguished Fellow :Public Policy

Consultants

Prof Srikanth Mutnuri, BITS Pilani Goa Campus.
Pradip Kishen, Forestry Expert
Prof Vinay Juvekar, L&T Chair Professor, IIT Bombay

A USD 1 million joint research initiative by IIT Alumni Centre, Bandhavgarh with BITS Pilani Goa Campus as external project partners. The initiative was launched on the sidelines of the G20 Biofuel Alliance launch in September 2023.

The biofuel byproduct facilitates bioremediation based on organic nano-peptides and microbial bio-augmentation for rejuvenating agricultural soil for organic farming and forest regeneration. It can also be mixed with products like nano-urea and biochar to create a suitable formulation which addresses soil deficiencies.

Project Objectives

- Remove invasives like Lantana which have taken over close to 60% of the land area of Bandhavgarh Tiger Reserve.
- Create a business case to use this Lantana as fuel for producing biogas and biofertiliser
- Biogas can be used for cooking and producing back up power in case of grid failure through fuel cells based on green hydrogen make from biogas pyrolysis. This prevents firewood cutting.
- Plant suitable native trees like Mahua and Sal in place of the Lantana
- Use the biofertiliser to enhance growth rate of trees
- Monitor the forest through remote sensing and hyperspectral imaging as per the ongoing project in the area by same group
- Set up project in neighbourhood to create livelihood from locals using forest produce like Mahua for exportable value added products like petroleum jelly substitute.

The Research PROJECT

An AI controlled precision bioreactor for the concurrent production of 500 tpa standardised Biogas & bioremediation soil mix from any available waste including coal, biomass, sewage, kitchen waste etc.

The economic problem being addressed...

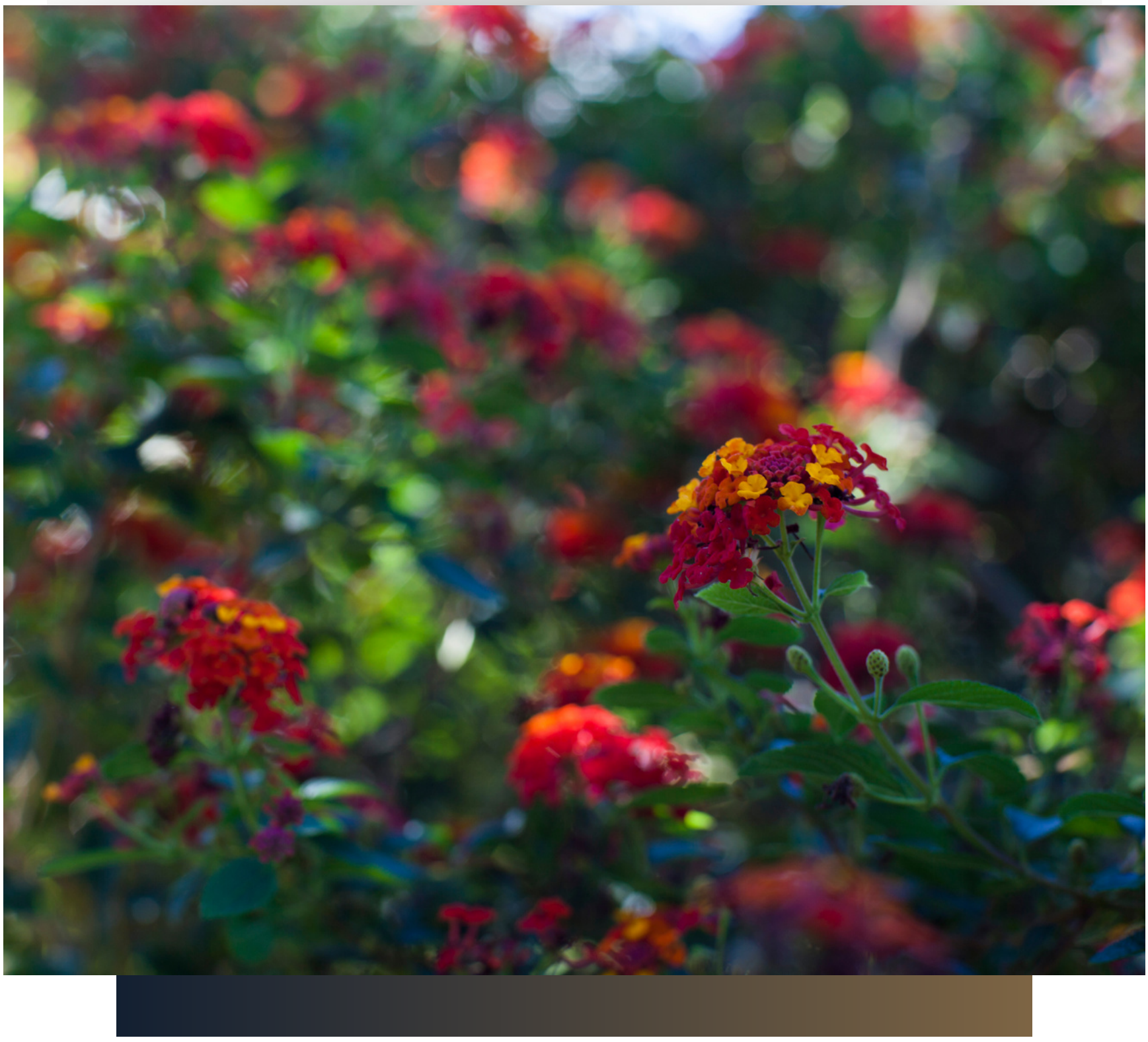
The principal challenge in the scaling up of biofuel production is the non-availability of standard input energy sources. This happens because of issues like seasonality of biomass availability, difficulty in prediction of material composition and logistics of raw material collection. As a result, these plants are not able to work at full capacity or around the year. If these bioreactors could be upgraded to use invasive plants like Lantana as fuel, the availability issue could be resolved.

It is not always possible to economically store gaseous fuels in large quantities. Whilst bio CNG is more valuable as a fuel for cooking or transportation - it may sometimes be desirable to convert it into electricity. These plants thus need to be connected to the grid so as to be able to deploy an optimal mix of renewables, biofuels and remotely generated power.

Thus, a plant design is required, which is:
multifuel input but standardised output.
with electricity generation and
grid interconnection.

Proposed Solution

and the underlying technology/ novelty/innovation driving the solution



The proposed project involves a completely new plant design with computervision to be able to use any available fuel including powdered coal, sewage, biomass, napiers grass, weeds/invasives etc. The primary focus is to use the Lantana invasive species which is available in almost unlimited quantities.

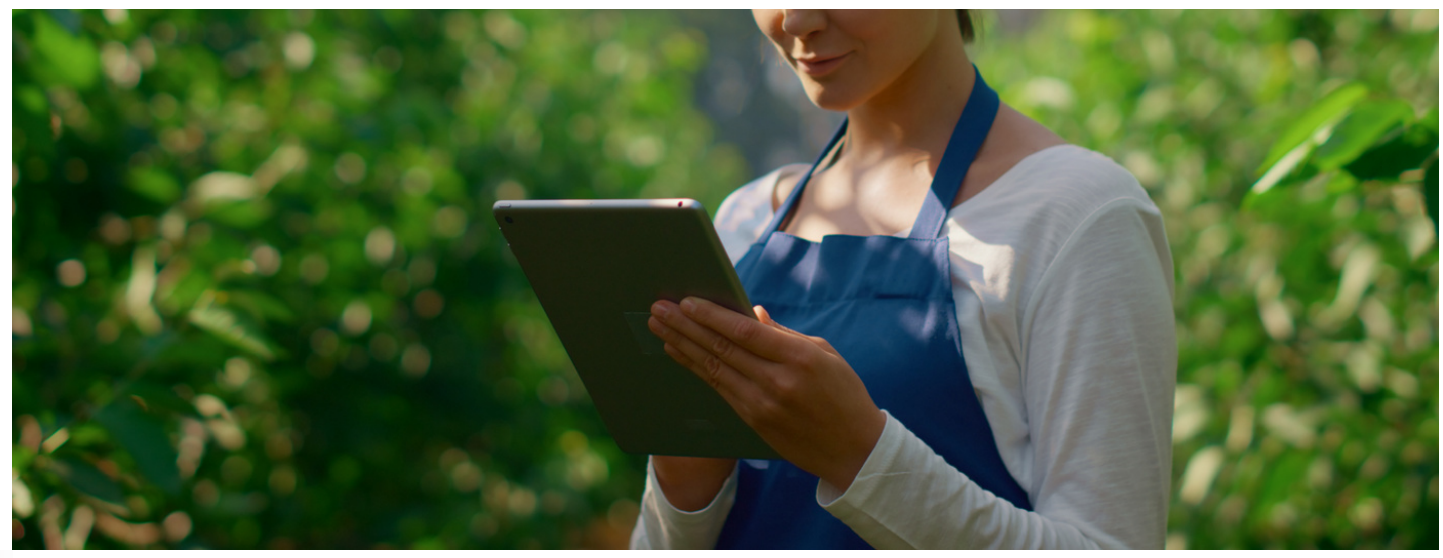
The proposed project involves three modules

input preparation - including separation

microbial conversion- with bio augmentation/stimulation

biogas distribution - or conversion to electricity

1st module



PREPARATORY MODULE
FEED PREPARATION

The preparatory phase involves identifying the key plants and species in the designated forest area which can be used as fuel for the biogas plant. Tentatively this plant has been identified as Lantana Camara which has covered an inidicative 60% of the 1500 sqkm area of Bandhavgarh Tiger Reserve making it a fuel source with almost unlimited availability. There is however a cost to extracting the plant, shredding it and transporting it to the reactor sight. This requires a prudent combination of robotics, cobotics, manual labour and machinery like precision water sprayers which will make it easy to unearth the plant along with its roots. Like any mining operation, a site plan has to be prepared and executed.

2nd Module

AI CONVERSION MODULE
CONTROLLED BIOREACTOR

The second module involves building an AI controlled bioreactor with facilities for bio-augmentation of the microbes to adjust for the change in input materials.

In order to reduce cost, the bioreactor is being built underground using a drinking well like deep column. This kind of design provides a large reactor volume which in turn permits large reaction times which are required to digest material like powdered coal.

Certain special additives need to be added to ensure that the harmful alkaloids contained in the Lantana are eliminated or destroyed in the compost.

3rd module

DISPATCH MODULE

DISTRIBUTION OR CONVERSION

The third phase involves purifying the output gas from the bioreactor to get bioCNG with rated/measured/ standard methane content - irrespective of the input.

The compost generated from the bioreactor is to be used for soil bioremediation.

The purified bioCNG can be distributed by pipeline or cylinders for cooking applications. It can also be filled into CNG vehicles.

Unused bioCNG can be converted into electricity via pyrolisis to hydrogen or through a closed loop turbine.

Stage of technology

The technology components are all individually proven and commercially available. What is missing is the development of a reactor with intelligent controls to allow the use of multiple input fuels. Using Lantana as the primary fuel requires certain special functionality to be built into the reactor.

The input management module uses Raman spectroscopy to identify the composition of the input material and then uses other inputs like coal or sewage to adjust the organic content.

Research

Biochar and organic manure and biomass addition and microbial inoculants to degraded agricultural or other soils can enhance cation exchange capacity and water holding capacity, restore healthy microbial activity and help sequester carbon.

We propose the conversion of waste biomass from invasive species such as Lantana into biochar and compost and its application to degraded soils. To track the improvement in soil conditions due to the interventions we will have 10 control plots (10m* 10 m) and compare them with the 10 treated plots (10m*10m) over time. We will measure cation exchange capacity, infiltration rate, water holding capacity, organic carbon and microbial communities at regular intervals in both control and treatment plots. Microbial communities will be measured using eDNA techniques. This will be done every year for a period of five years.

References for methods:

Krishnaswamy, J. and Richter, D.D., 2002. Properties of advanced weathering-stage soils in tropical forests and pastures. Soil Science Society of America Journal, 66(1), pp.244-253.

Mehta, V.K. et al., 2008. Impacts of disturbance on soil properties in a dry tropical forest in Southern India. Ecohydrology: Ecosystems, Land and Water Process Interactions, Ecohydrogeomorphology, 1(2), pp.161-175.

Domingues, R.R. et al., 2020. Enhancing cation exchange capacity of weathered soils using biochar: feedstock, pyrolysis conditions and addition rate. Agronomy, 10(6), p.824.

Yang, D.I.N.G. et al., 2017. Potential benefits of biochar in agricultural soils: a review. Pedosphere, 27(4), pp.645-661.

Van Der Heyde et al., 2020. Changes in soil microbial communities in post mine ecological restoration: Implications for monitoring using high throughput DNA sequencing. Science of the Total Environment, 749, p.142262.

Competition

To the best of our knowledge, there is no readily available solution for multi-fuel-based biogas.

There are some startups which have developed solutions of various kinds for similar raw materials. For example startups like Takachar address the biomass disposal problem by pyrolysing the biomass into biochar which can be mixed with soil.

However this approach does not produce any biofuel. Activated carbon which is used for detoxification of soil is produced from sources like coconut husk. It can also be produced from pyrolysis of methane into carbon and hydrogen. The hydrogen can be used to produce electricity through a fuel cell.

Based on published research,there may be some merit in mixing biochar in the biofertiliser to improve its efficacy. Also biochar can be made with a transportable machine at the site of the lantana plants. This approach is being incorporated as part of the research projects associated with the overall project.

Business plan & commercialisation strategy

Our business plan is to market bioCNG through cooking cylinders, piped gas, CNG vehicles and conversion into electricity for grid /home use or EV charging.

This kind of a power plant is an ideal addition to renewable power to meet the needs of a self contained and independent smart village.

Societal impact of service

Biomass disposal is a challenge. Burning biomass in the fields leads to emission of particulate matter and green house gases. Conversion of biomass into biogas solves the problem of air quality index in neighbouring areas.

There is virtually unlimited quantities of Lantana in the Bandhavgarh Forest Reserve of 1500 sqkm

Invasive species like Juliflora and Lantana reduce the carbon sequestration capacity of the forest. They also make the land unfit for agriculture and destroy biodiversity.

Fossil fuels like coal will need to be phased out from use in coal boilers. So a way to produce clean power from coal is a pressing requirement for the energy security of India. Coal to gas is one option for clean conversion of coal.

MEGAREACH

GLOBAL ALUMNI OUTREACH AND PARTICIPATION

anniversary.iitac.online

MEGAREACH

PanIIT Alumni Pvt Ltd is the anchor organisation of the MegaReach mission - the alumni outreach and networking arm of the IIT Alumni Council.

IIT Alumni employed in the corporate sector form the largest single community within the IIT Alumni group. This segment forms the backbone of the MegaReach mission.

IIT Alumni occupy leadership roles in key corporates in India as well as overseas. These corporates are key contributors to the social initiatives of the IIT Alumni Council from their CSR budgets.

FORUM

PROJECT IMPLEMENTATION AGENCY

pip.iitac.online

A central project implementation and compliance platform which implements pilot projects for technology demonstration and validation. The Forum also does esg, environment and concurrent audits for impact assessment studies.

Forum is the project implementation agency for design, construction and operation of the biofuel plant.

INSTITUTE

APPLIED
RESEARCH
ORGANISATION

institute.net.in

A research platform which identifies appropriate resources from industry, research institutions and academia to meet the needs of ventures and projects supported by the various mission organisations and facilitators of the IIT Alumni Council.

The Institute nominates researchers from the awarded Distinguished Fellows for each project.

Srinivas Rachakonda

A seasoned corporate leader from the oil and gas industry. Senior Advisor McKinsey & Co, former President Essar Oil and founding team member that built the Jamnagar oil refinery. A Chemical Engineer from IIT Bombay, Srinivas left his global corporate career and an eight-digit salary to move to a remote village in the Bandhavgarh Tiger Reserve's buffer zone in Madhya Pradesh, India.

He was awarded the Change Maker of the Year 2023 and is rated amongst the leading thought leaders globally in the area of elimination of invasive species.

He runs the Prakriti Prerna Foundation, addressing the challenges of mass dense afforestation in the area. Srinivas believes his work will create a new industry worth billions of dollars in climate change-related revenues while also undoing some of the harm caused by the chemical plants he helped build.

Jagdish Krishnaswamy

An ecohydrologist, academician and subject matter expert in environmental studies, Dr Krishnaswamy is a civil engineer who graduated from IIT Bombay and holds a Master's and PhD from Duke University in Environmental sciences. His post-doctoral work in Ecology and Environment was at the Ashoka Trust for Research, where he served as a fellow and Professor till 2021. He is the Dean of the School of Environment & Sustainability at the Indian Institute of Human Settlements in Bangalore, India

He was awarded the Distinguished Fellow in ecohydrology for 2023 by the IIT Alumni Council.

Dr Krishnaswamy has coordinated the establishment of instrumented catchments in the Western Ghats and in the Himalayas to study the impact of land cover and climate variability on hydrological processes.

Neelkant Shukla

An accomplished senior leader in strategy, engineering, and technology, Dr Shukla has close to thirty years of work experience as a Chemical engineer and has been a tall corporate leader in green chemistry, sustainability and in building net-zero industries.

Dr Shukla was awarded the Distinguished Fellow by the Institute as the most eminent IIT Alumni Council member in the world in the area of Carbon sequestration.

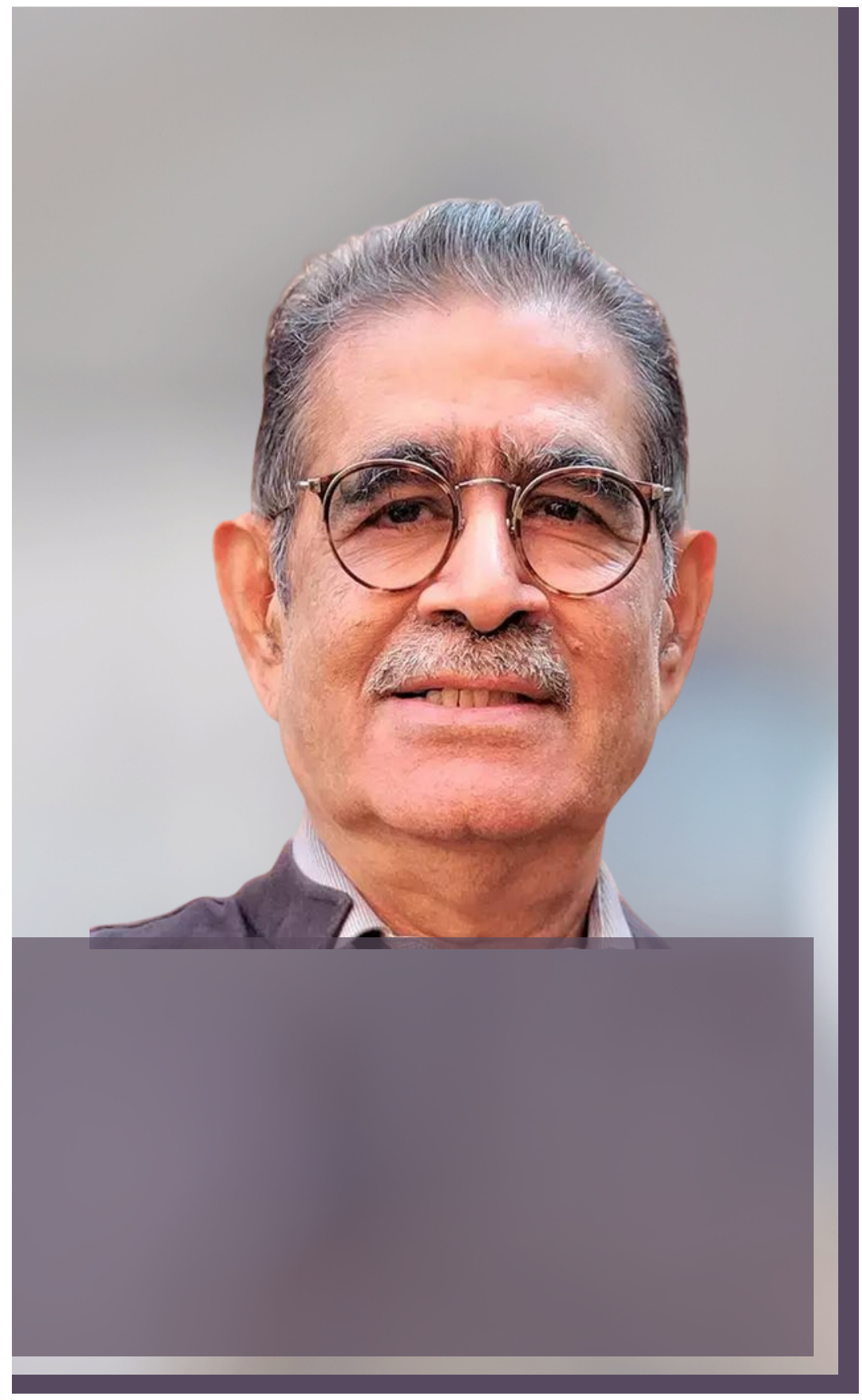
Neelkant holds a B Tech from IIT Bombay, an MS & PhD from the University of Louisville, all in Chemical Engineering. He is an adjunct faculty of Rowan University in New Jersey. He speaks his mind and is routinely invited to chair alumni events in his domain.

Mahesh Uppal

One of the foremost experts in India in the area of public policy and telecom strategy, Mahesh holds a PhD from IIT Kanpur. He is an alumnus of St Stephens, New Delhi, City University, London and Cambridge University.

He has advised national and global businesses, UN and other international agencies, as well as civil society groups. As a consultant, he has closely tracked the evolution of India's telecom sector. He was awarded as a Distinguished Fellow in the area of Public Policy.

Dr Mahesh Uppal was part of the core team which helped conceptualise the IIT Alumni Council and related entities between 2014-19. He contributed extensively to the process of creating TRAI. His view points on emerging policy and regulatory issues are covered by the media as a recognised authority in the filed.



Consultants

Coal2gas
Green Chemistry

Sitadal Technologies
Heat to electricity

Prof Srikanth Mutnuri
Biogas plant design and operations

Pradip Kishen
Social Forestry

Prof Vinay Juvekar
Quantitative Modelling

COAL2CNG

MICROBIAL METHANATION OF COAL TECHNOLOGY

coal.iitac.online

COAL2CNG

COAL2CNG initiative envisages converting underground coal into CNG at a global scale with an ambition to make India the largest producer of CNG within ten years.

The energy basket envisaged includes coal, thorium and solar with all the coal being converted to CNG and thorium being used as a fuel for nuclear energy.

SITADAL TECHNOLOGIES

CONVERTING HEAT TO ELECTRICITY, DIRECTLY OR VIA HYDROGEN

sitadal.com

Sitadal is building the core technologies for converting heat into electricity with cooling as a byproduct. The company has developed three platforms for conversion. These include thermolysis to produce hydrogen for fuel cells, direct conversion via nextgen closed loop turbines and peltier effect based TEGs.

Srikanth Mutnuri

Biological Sciences

A professor at the Department of Biological Sciences, BITS Pilani, Goa campus, Dr Srikanth Mutnuri's lab has received grants from DST, DBT, BIRAC, Bill & Melinda Gates Foundation, CEFIPRA, German Technical Cooperation etc. He has demonstrated waste-to-energy plants based on Biogas wherein he installed one ton-per-day organic waste-based biogas plant, and provided technical support to the German Technical Cooperation for implementing 30 tons per day Biogas plant at Nashik where the substrates was an organic fraction of Municipal solid waste and septage. He also demonstrated a 5-ton-per-day biogas plant using OFMSW and septage in Goa.

He is also part of the Prof Shannon Yee, Georgia Tech USA global research team of over 70 engineers, scientists, and industrial designers in developing, and now testing, a portfolio of reinvented toilets that bring together the best concepts from the last decade of the Bill & Melinda Gates Foundation-led Reinvent The Toilet Challenge

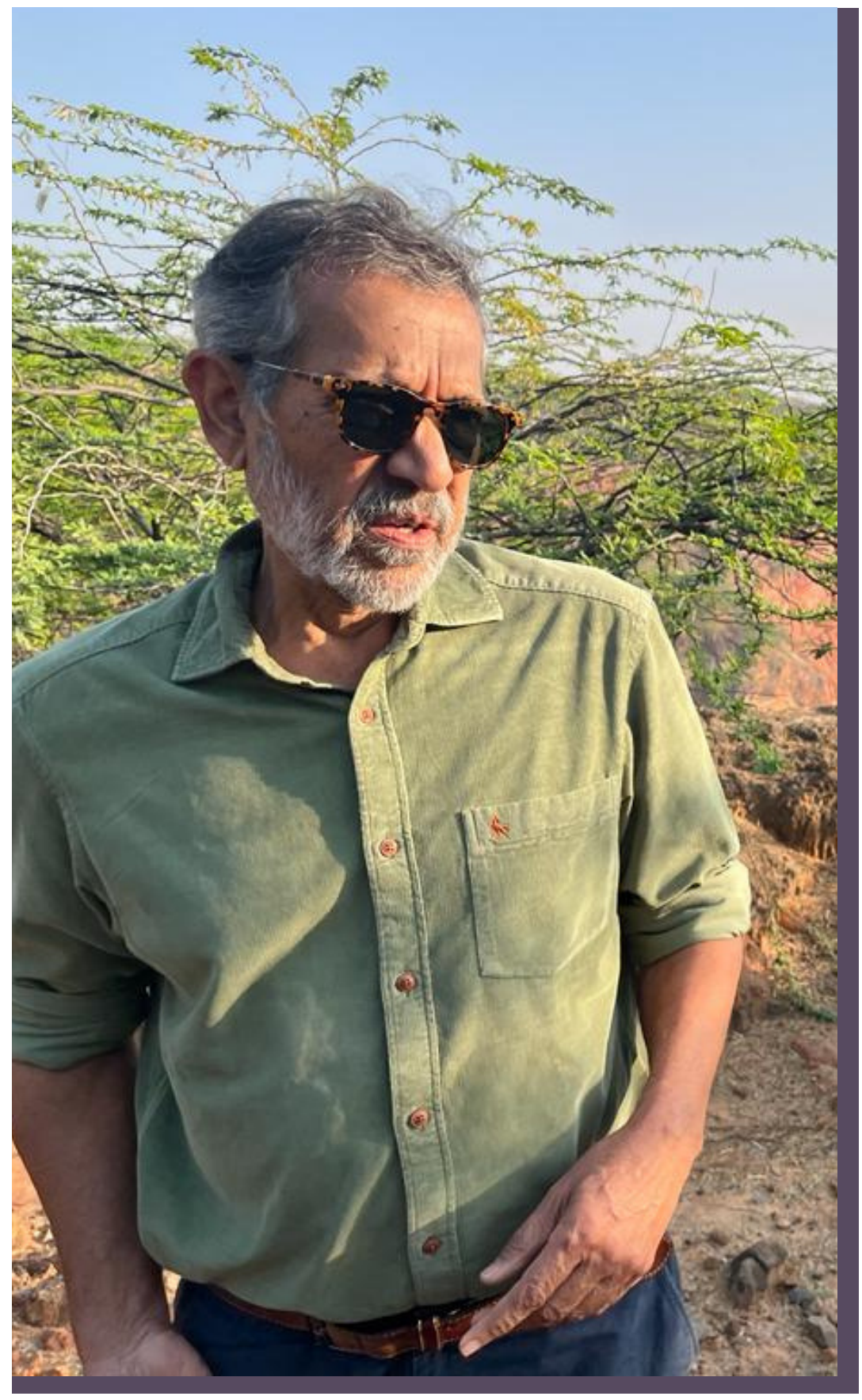
Pradip Kishen

Forestry

An award-winning documentary and feature film maker, Pradip Kishen is a graduate of St Stephens, Delhi University and Balliol College, Oxford University.

For the last twenty years, he has been doing pioneering restoration work in North India and has been involved with creating some iconic bio-diverse vegetation hubs in desert areas. These include desert parks in Jodhpur and Jaipur of around 70 hectares each.

Pradip started writing about trees and forests in 1987. He has authored several books on Indian trees and forests and is widely regarded as the most authoritative source on the subject globally. His books on trees of Delhi and North India are by far the most respected and referred-to publications in the forest revitalisation domain.



Vinay Juvekar

Reactor design

A highly acclaimed and well-regarded academician, Prof Vinay Juvekar is an alumnus of UDCT, Mumbai University and spent a significant part of his career as a faculty of the Dept of Chemical Engineering, IIT Bombay. He served as the L&T Chair Professor of Chemical Engineering at IIT Bombay.

He is widely considered one of Asia's best chemical engineering academicians, with several publications, patents and research findings.

Prof Juvekar joined IIT Bombay in 1984, and over the last 40 years, he has played a vital role in developing indigenous technologies in petrochemicals and various other aspects of chemical engineering such as colloids and nanotechnology. In recent years, he has applied his knowledge of quantitative modelling to areas such as microbial reactors and micro/nanosystems.

The Climate Change Initiative

The Climate Change Initiative of the MegaFund mission of the IIT Alumni Council is the largest privatenon-profit climate change projectof it’s kind in the world

It is configured to catalyse a global paradigm shift through electrification, energy transition, migration reversal, healthspan enhancement and forest revitalisation

The big picture

In order to meet the core objective of revitalising the forest area in and around the Bandhavgarh Tiger Reserve, the IIT Alumni Council missions have sponsored five synergistic projects:

Real-time monitoring of carbon absorption capacity

carboncredit.iitcouncil.org

Replacement of Lantana with native trees like Mahua & Sal

lantana.iitcouncil.org

Livelihoods based on value added forestry produce

mahua.iitcouncil.org

Market access for forestry products and other organic produce

shambhala.net.in

Smart integrated health villages in each state of India

ayushca.org

The Social Impact

Along with the COAL2GAS project*
and the Ionique Perpetual Power project**
these seven projects constitute the largest climate change initiative in the private non-profit sector anywhere in the world. The eventual target is to:

Revitalise 100,000 sq. kms of native forests in four hubs of India under the Shambhala Forestry mission so as to double their carbon sequestration capacity within ten years.

Create a USD 10 Billion infrastructure for health and wellness which fuses ancient wisdom with cutting-edge theranostics from the MegaLab mission.

Convert all underground coal into cleaner CNG, which can be used to replace:

- firewood as a cooking fuel
- gasoline as a transportation fuel
- thermal power with hydrogen-derived green electricity

Develop perpetual power zero carbon solutions for EV charging in strategic applications, including interstellar, underwater and remote area habitats.

Use paradigms from the startup and
venture capital ecosystem to foster deep tech ventures that solve climate change challenges.

*coal.iitac.online

**ioniqe.iitcouncil.org

MEGAFUND

SOCIAL FUND REGULATED AS AN AIF FUND BY SEBI

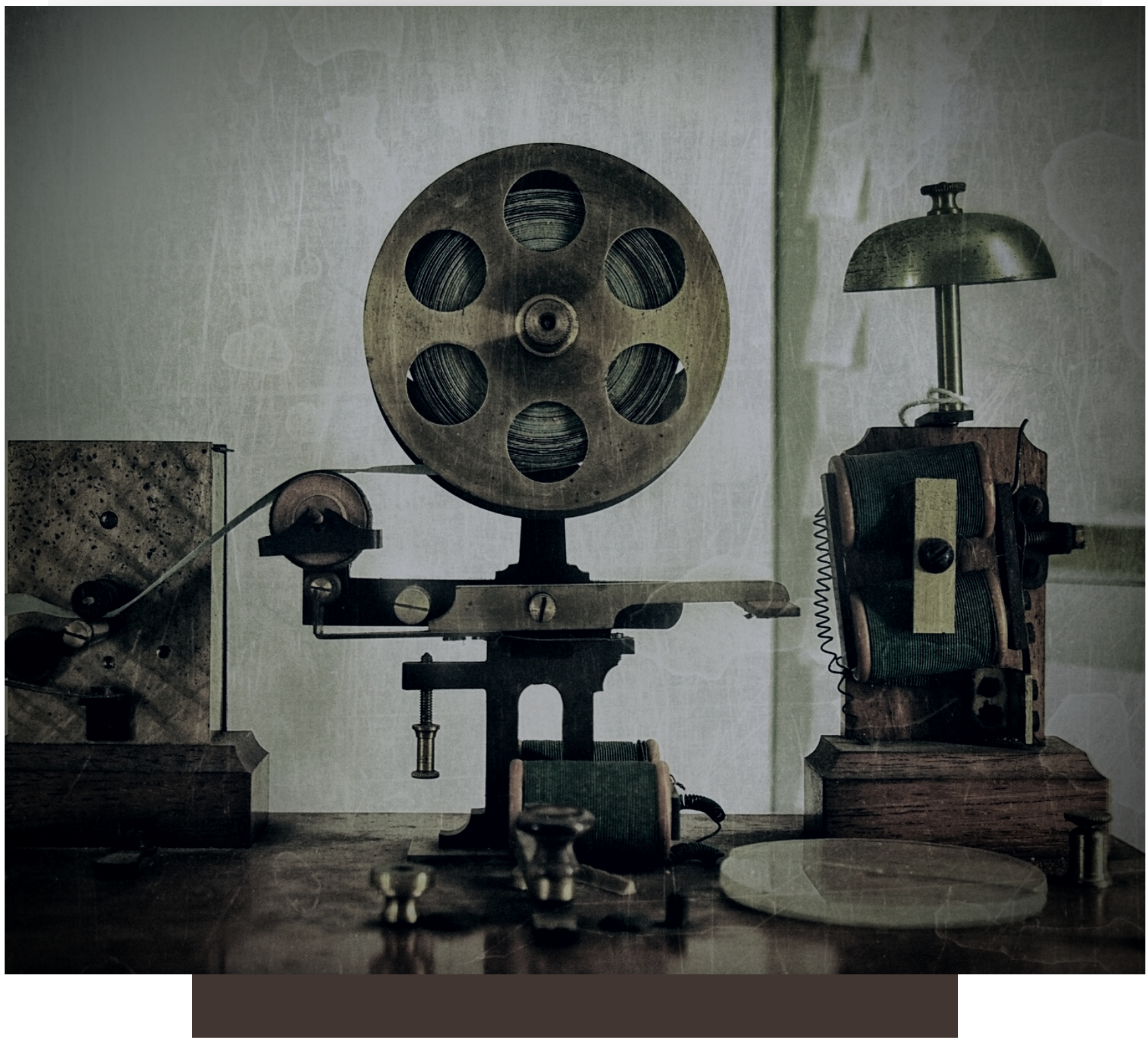
megafund.in

The MegaFund is a consortium of social and venture capital funds with a target corpus of Rs 21,000 crores and a fund life of twenty years.

The anchor entity PanIIT Fund is registered with and regulated by SEBI under the Social Impact Fund framework under the AIF Regulations 2012.

The MegaFund promotes the progress of science and technology, advances national health and prosperity and helps to secure and lead in key strategic technologies including climate change.

Communications



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Plans to protect
air and water, wilderness
and wildlife are, in fact,
plans to protect man.

Stewart Udall

iit ALUMNI COUNCIL