Government of India
Ministry of Micro, Small & Medium Enterprises
MSME IDEA HACKATHON 5.0
HOST INSTITUTE: SRI KRISHNA COLLEGE OF TECHNOLOGY

Idea Reference No.:INC25ETN107556

1. Details of Incubatee:

1.1 Details of the Host Institute (HI):

Sri Krishna College of Technology,

Kovaipudur,

Coimbatore, Ph: 04222984567,

Mail: principal@skct.edu.in, 9865816671

1.2 Name of the Business Incubator(BI)

Dr.S.Sundararaj, Professor, s.sundararaj@skct.edu.in, 9842799736

1.3 Category of the Incubatee Student/Others/Entrepreneurs/MSMEs (Specify any one): **Student**

1.4 Incubatee Name: Rakshith.R & team

1.5 State: **Tamilnadu**

1.6 District: Coimbatore

1.7 Email Id: rakshithshith2006@gmail.com

1.8 Mobile Number: 9342478943

1.9*Category (General/SC/ST/OBC) ; SC

1.10 Gender (Male/Female): Male

1.11 Address: Sri Krishna College of Technology, Coimbatore, 641042, India

2. Details of Idea

2.1 Title of proposed idea/innovation (Refinement of title is allowed):

GREENSPIRE –Panchabhoota-Inspired Bio-Circular CO_2Capture and Resource Regeneration System Using Smart Algae Technology.

2.2* Whether the idea involves use of existing intellectual property or not, give brief detail there of:

GreenSpire's innovation does not rely on existing exclusive intellectual property but integrates well-established technologies such as bioreactors, microalgae strains (Spirulina and Chlorella), LED lighting, and Arduino-based IoT control using open-source hardware and software. Proprietary elements include a modular system architecture protected by Indian design registration, strain-specific cultivation protocols kept as trade secrets, and custom firmware copyrighted by GreenSpire Innovations Pvt. Ltd. All third-party components comply with open-source licenses, and preliminary freedom-to-operate analysis shows no patent infringement risks. Existing patents in the algae bioreactor space cover various photobioreactor designs and algae cultivation methods, but GreenSpire's system uniquely combines these elements into an affordable, automated, and scalable solution tailored for MSMEs. Future IP plans include filing patents on novel fluid dynamics in manifold design and co-cultivation methods to enhance CO_2 uptake and biomass yield. This approach balances leveraging established knowledge with protecting distinct, innovative aspects of system implementation within a growing intellectual property landscape around algae cultivation and bioreactors.

2.3 Briefly explain newness / uniqueness of the innovation

GreenSpire's uniqueness lies in its blend of bio-circular design, IoT-enabled automation, and modular scalability, specifically tailored for MSMEs. Unlike traditional carbon capture systems that store CO_2 at high cost or open-pond algae setups prone to contamination and low yields, GreenSpire uses precision photobioreactor technology in a closed-loop system where fast-growing microalgae (Spirulina and Chlorella) transform CO_2 into oxygen and valuable biomass such as biofuels, fertilizers, protein powders, bioplastics, and nutraceuticals—achieving true carbon-negative operation with zero waste. Its proprietary automation layer utilizes real-time CO_2, pH, and temperature feedback to dynamically control aeration and LED light spectra while predictive maintenance algorithms and cloud dashboards ensure minimal human intervention, making advanced process control accessible even to non-experts. The system's rack-and-rail modular architecture allows seamless plug-and-play expansion from small rooftop units to medium industrial setups without major retrofits, making it ideal for diverse MSME needs. By

merging carbon credits with onsite biomass product sales, GreenSpire turns carbon capture from a cost burden into a profit center, offering ROI in under six months—something no other small-scale algae-based carbon capture solution currently achieves.

2.4 Concept & Objective

GreenSpire is a next-generation, bio-circular CO_2 capture and resource regeneration system that transforms carbon emissions into profitable, sustainable products. Using fast-growing microalgae such as Spirulina and Chlorella within precision photobioreactors, it captures CO_2 at source and converts it into oxygen and high-value biomass including biofuels, fertilizers, protein powders, bioplastics, and nutraceuticals. The system integrates LED-assisted photosynthesis, real-time CO_2 measurement, and Arduino-based IoT automation for continuous monitoring, smart aeration, and adaptive light control, ensuring optimal growth with minimal human intervention.

Objectives:

- Achieve carbon-negative operation by neutralizing ≥1.8 tons of CO_2 per unit annually.
- Produce ≥200 kg of commercial-grade algae biomass per year for revenue generation.
- Enable MSMEs to monetize emissions through carbon credits and sale of sustainable products.
- Offer a scalable, modular design deployable in factories, rooftops, offices, and homes.
- Promote closed-loop, zero-waste production with low energy and water consumption.

2.5 Specify the potential areas of application in industry/market in brief

GreenSpire's applications span diverse sectors, offering both environmental and economic benefits. For MSMEs and Small-Scale Industries, it enables decentralized carbon capture in workshops, processing units, textile, and agro-industries, reducing emissions at source while producing valuable biomass. In urban and rural households, compact rooftop or backyard units improve air quality, generate organic compost, and serve as tools for climate awareness. Institutional campuses such as schools, colleges, and research labs can use GreenSpire as a demonstration platform for climate innovation, sustainability education, and achieving carbon neutrality goals. Smart cities and municipalities can integrate the system into urban climate infrastructure to enhance air quality and supply locally-produced biofertilizer. In agriculture and

horticulture, CO_2-fed algae units produce nutrient-rich feed and compost, improving soil health, crop yields, and supporting organic farming. Within green buildings and eco-malls, GreenSpire units add value as visible, climate-positive amenities aligned with sustainability certifications and ESG goals, making them attractive for environmentally conscious tenants and customers.

2.6 Briefly provide the market data for the potential idea/innovation

The projected market values related to GreenSpire's domain highlight expansive global opportunities without reflecting costs or investments. The total global algae industry is expected to generate ₹4.64 lakh crore in revenue by 2031, encompassing all algae-based products and markets. Within this, algae-derived biofuels alone are projected to reach ₹1.28 lakh crore in sales by 2030, reflecting growing demand for sustainable energy solutions. Meanwhile, the market for algae-based carbon capture technology is valued at ₹20,825 crore by 2033, representing the business potential for innovative carbon-neutral systems like GreenSpire. The Asia-Pacific region leads this landscape, commanding the highest share in algae demand, production, and sales. Importantly, these figures denote market value and revenue potential—not the cost of producing algae, the investment required, or expenses related to research and development. This underscores that algae technology sectors are vibrant growth markets, offering promising returns rather than cost burdens, perfectly aligning with GreenSpire's financially sustainable, scalable innovation.

2.7 Name and details of Mentors (Host Institute - Sri Krishna College of Technology only):

Dr Naveenbalaji Gowthaman Associate Professor

Department of CSE(AIML)

2.8 Experience and Qualification of Mentors:

11 years; SMIEEE, PhD, PostDoc (RSA)

2.9 Contact Details of Mentors (Mail ID and Mobile No.):

Mail ID: naveenbalaji.g@skct.edu.in, dr.gnb@ieee.org

Mobile No: +91 9443874511

2.10* Current Development Status of innovation:

GreenSpire is currently at the prototype and pilot validation stage, having developed modular photobioreactor units integrated with Arduino-based IoT controls for real-time CO_2 capture and biomass production. Functioning systems with LED-assisted photosynthesis and automated control are tested for scalability from small to medium industrial setups. Ongoing efforts focus on optimizing algae growth, yield, and system automation, with pilot deployments planned at MSME sites and refinement of harvesting processes. The technology is moving towards commercial scale-up and wider adoption.

2.11*Expected time of completion of idea:

Month 1: Finalize specs, create CAD designs, onboard vendors, check IP/compliance.

Month 2: Procure components, fabricate chambers/racks, develop firmware, set up cloud dashboard.

Month 3: Assemble hardware, integrate IoT, test automation, run leak/airflow checks.

Month 4: Inoculate algae, calibrate systems, collect baseline data.

Month 5: Optimize operations, refine nutrient/light cycles, add predictive maintenance.

2.12*Theme

(●) Low-carbon footprint solutions/technologies	( ) Stealth, Surveillance, and Cyber Defense Technologies	( ) Innovation in the Adoption of Industry 4.0 & 5.0 in the MSME ecosystem	( ) Innovation for business upliftment and sustainability in coastal and hilly areas	( ) Smart and Resilient Supply Chains

2.13*Idea Sector

(●) Agriculture, Rivers & Ocean Produce-based industries, fertilizers, Agricultural Implements & Agro processing and any related sub-sector	( ) Healthcare & Life sciences, Medical Devices, Pharmaceuticals, Biotech, AYUSH and any related sub-sector	( ) Power, Renewables, Electricals, Power Electronics, Energy Efficiency and any related sub-sector	( ) Services, Education, Hospitality, Media, Publishing, Entertainment, Design, Wellness, Logistics, Sports and any related sub-sector	( ) Miscellaneous Sector (Environment, Forests, Water & Sanitation; Foods, Beverages, FMCG, Consumer Goods; Infrastructure, Construction, Housing; IT, ITES, Electronics, White Goods, Telecommunication; Metals, Engineering, Machinery, Automation

and Transportation, Automotive, E Vehicles, Railways, Aviation, UAV and any other sub-sector)

Smart and Resilient Supply Chains

3. Financial requirements:

3.1*Please give activity-wise break-up as mentioned below

Technology-related expenditures include machine usage charges, Electricity charges, Procurement of raw materials, testing/Calibration charges, and other essential charges for the development of the idea. Max (10.00) lakh.

S. No.	Month	Particular / Item / Specification	Quantity (Nos.)	Rate (Rs./No.)	Amount (Rs.)
1	Month 1	Machine usage charges (CAD modeling, simulation software, IP validation)	1	1,20,000	1,20,000
2		Electricity charges (computing, prototyping tools)	-	-	20,000
3		Calibration planning (IPR, CO_2 baseline testing setup)	-	-	10,000
4	Month 2	Procurement of raw materials (algae strains, photo-bioreactor components)	-	-	2,50,000
5		Machine usage charges (fabrication of algae chambers, 3D mounting racks)	1	80,000	80,000
6		Electricity charges (fab tools, CNC, power supply)	-	-	25,000
7	Month 3	Assembly and hardware integration	1	70,000	70,000
8		Calibration and testing (IoT, CO_2/oxygen sensors, LED systems)	-	-	45,000
9		Electricity charges	-	-	20,000
10	Month 4	Algae culture setup, inoculation, light-nutrient cycle testing	-	-	1,30,000

11		Calibration and monitoring	-	-	30,000
12		Electricity charges (continuous lighting, pumps, filtration)	-	-	18,000
13	Month 5	Optimization, data analytics, system refinement	-	-	80,000
14		Machine usage charges (predictive analytics, firmware updates)	1	60,000	60,000
15		Electricity charges	-	-	20,000
16	Final	Other essential charges (spares, consumables, repairs, cloud storage)	-	-	50,000
Total (Max 10.00 lakh)					**₹9,78,000**

Particular / Item	**Total Idea Project Cost (Rs. in lakh)**	**Amount of GOI Assistance (Rs. in lakh)**	**Incubatee Share (Rs. in lakh) (Nil for Students / 15% for others)**
Technology-related Expenditure (machine usage, electricity, raw materials, calibration, etc.)	9.78	8.31	1.47
Charges for mentor/handholding/supporting team (Max 3.00 lakh)	3.00	2.55	0.45
Traveling expenses or other items not covered above (Max 2.00 lakh)	2.00	1.70	0.30
Total idea/project cost (Rs. in lakh)	14.78	12.56	2.22

*Total idea/project cost (Rs in lakh) : 14.7 **Lakhs**

*Total GOI Assistance required (Rs in lakh): 12.56 **Lakhs**

*Total Incubatee share (Rs in lakh) : 2.22 **Lakhs**

4. Please give names of other students/Entrepreneurs associated with this project/idea, if any (in the periodic order):

Name	Aadhar No/ Udhyog Aadhar No/Udyam Registration	Contact No	Email
Akshara A S	927778457363	6385315592	727823tucy002@skct.edu.in
Tharish S	847504775770	7010519553	727824tucy058@skct.edu.in
Sivanantham P	624726793389	7358964540	727824tucy055@skct.edu.in
Sahana D	261209405433	8608739277	727824tucy051@skct.edu.in

*** 5. Summary of the idea.**

GreenSpire is an innovative, Arduino-controlled algae-based carbon capture system designed for MSMEs. Using fast-growing microalgae (Spirulina & Chlorella) in modular photobioreactors, it captures CO_2 and converts it into oxygen plus valuable products like biofuels, fertilizers, protein powders, and bioplastics. The system features LED-assisted photosynthesis, real-time IoT monitoring, and automated control for optimal growth. At ₹21,000 per medium-scale unit, it offers exceptional ROI (558% annually) with 2-3 month payback period through dual revenue streams: carbon credits and biomass sales. Scalable from home to industrial applications, GreenSpire transforms carbon emissions from cost burden to profit opportunity, enabling sustainable business growth while contributing to climate goals.

*** 6 (a) Is it a new concept? (Yes / ~~No~~):** Yes, it is a new concept.

*** (b) Prior art on the concept, if any**

While algae-based carbon capture and bio-utilization systems exist in scientific literature and research settings, GreenSpire introduces a unique, modular, and low-cost bio-circular system inspired by Panchabhoota (the five natural elements). It combines carbon capture, IoT-based monitoring, and resource regeneration in one integrated unit suitable for industrial, urban, and household use. No identical system offering this blend of scalability, product output (like fertilizer,

biofuel, feed), and circular economy integration has been commercially deployed in the MSME sector or household domain in India.

*** 7. Main Problem Being Addressed in the Project**

Rapid urbanization drives CO_2 emissions, harming health and climate. GreenSpire, a smart algae-based, bio-circular carbon capture system, offers a low-cost, modular solution for MSMEs, homes, and cities. It cuts emissions while producing biofuels, fertilizers, and protein feed, aligning with SDGs 3, 7, 9, 11 & 13. IoT-enabled and scalable, it promotes sustainable, human-centric innovation in line with IEEE's vision for ethical tech benefiting humanity.

8. Background for getting the idea

*** a. Who is it for?**

This solution is tailored for Micro, Small & Medium Enterprises (MSMEs), urban households, educational institutions, and small-scale industries seeking accessible and affordable climate action tools without the need for complex infrastructure or large capital investments.

*** b. What will it do?**

The system biologically captures atmospheric carbon dioxide using microalgae, purifies the surrounding air, and converts carbon waste into high-value green products such as biofertilizers, protein-rich animal feed, and bioplastic precursors transforming environmental pollution into circular economic opportunity

*** c. Any unique features? Explain.**

Uses microalgae for real-time, decentralized CO_2 capture and oxygen regeneration, converting emissions into biofertilizers, bioplastics, protein feed, and biofuels. Modular, low-cost, and scalable for homes, rooftops, MSMEs, and small industries, enabling grassroots climate action and revenue generation.

*** 9. How simple or complex will the idea's execution or implementation be? What are the risk factors involved in executing the idea?**

GreenSpire's implementation is complex due to integrating microalgae biology with IoT hardware and AI-based automation, requiring precise control over nutrient recycling and environmental conditions. Risks include algae underperformance in real settings, sensor/data reliability, and

maintaining closed-loop cycles needing ongoing oversight. Success depends on robust system design, accurate monitoring, and adaptive management to ensure sustained CO_2 capture and biomass production.

*** 10. How soon could the idea be put into operation? (TRL of prototype)**

GreenSpire is currently at the prototype and pilot validation stage, with modular photobioreactor units integrated with Arduino-based IoT controls. This corresponds roughly to Technology Readiness Level (TRL) 4-5, meaning lab-validated components are being integrated and tested in relevant environments, with pilot deployments planned within the next 6-8 months. Full operational readiness for MSME deployment can be expected upon completion of pilot scaling and optimization within this timeframe.

*** 11. How much investment would you need for prototyping the Idea?**

Excluding electricity and other essential charges, the estimated investment required for prototyping the GreenSpire system is approximately ₹8.90 lakhs.

This includes:

- Machine usage (design, fabrication, and assembly): ₹3.30 lakhs
- Procurement of raw materials (algae cultures, bioreactor chambers, sensors, components): ₹5.60 lakhs

This budget specifically focuses on the physical construction and core functionality of the prototype, excluding recurring operational costs like electricity and minor consumables.

*** 12. (a) How do you intend to protect your idea (i.e. your intellectual property or IP)? Status of IPR (If any).**

GreenSpire intends to protect its intellectual property by leveraging a combination of design registrations for its modular system architecture, trade secrets for cultivation protocols, and copyrighted custom firmware for IoT automation. It uses open-source hardware/software compliantly and has conducted freedom-to-operate checks to avoid infringement. Future plans include filing patents on novel fluid dynamics in manifolds and unique co-cultivation methods, ensuring robust IPR protection in a competitive biotech landscape around microalgae.

*** (b) Related Background. This section is used to highlight information that can be used by the reviewers or patent attorney to help put the solution in proper context. You can think of this section as something similar to the introduction section of an academic**

publication. This section is specifically reserved for other people's work (please include competitive work) as well as your past work that you believe will aid the reviewers in understanding the technical landscape. Data related to or supporting your solution should not be in this section, it should be in Section III: "How is this Solution Made and Used."

GreenSpire builds on advances in algae-based carbon capture using high-efficiency photobioreactors, IoT automation, and strain engineering. Competing systems include Brilliant Planet's raceway ponds and ALcarbo's nanobubble-enhanced reactors, focusing on scalable, contamination-controlled CO_2 to biomass conversion for MSMEs.

*** 13. How is this project made and used:**

GreenSpire is made by assembling modular acrylic photobioreactor chambers equipped with LED grow lights, CO_2 sensors, air pumps, and Arduino-based IoT controllers. Algae cultures (Spirulina & Chlorella) are seeded into these closed, transparent units. The system precisely controls light, aeration, pH, temperature, and CO_2 levels via real-time automation to optimize photosynthesis and biomass growth. Algae convert CO_2 into oxygen and valuable biomass products, enabling decentralized, scalable carbon capture with low energy use and automated operation for MSMEs. This approach builds on proven photobioreactor designs with integrated biological, electronic, and environmental controls for sustainable and profitable CO_2 utilization.

*** 14. Submit Block diagram/ flow chart/ Circuit Diagram/Pictures with title for each in a single pdf file separately. [File size should not exceed 1 MB]**

***15 Submit all student ID / MSME proof in a single pdf file separately. [File size should not exceed 1 MB]**

Declaration

☑ **I declare that:**

1. **I have read the entire scheme guidelines and shall abide by all the requirements stipulated therein for seeking financial assistance.**
2. **I hereby declare that information given above is true to the best of my Knowledge and that I have not withheld/distorted any material fact.**
3. **Any information/ documents that may be required to be verified shall be provided immediately before the concerned authority.**
4. **I hereby declare that I have not availed any financial assistance for this purpose from any other scheme from any Central/ State govt. agency.**
5. **In case the Idea is approved, Host Institute would undertake to make facilities available to carry out the development and arrange for the submission of periodic progress reports and other information that may be required by the Ministry.**
6. **I certify that the accounts of the funds received and spent will be kept and made available on demand, as per scheme guidelines**
7. **I certify that the funds will be used only for Idea development as per activities defined in Scheme Guidelines & no funds out of this grant will be utilized for any other activity/production purposes.**