



SPRERI
Striving for Excellence

2024-25 ANNUAL REPORT



**SARDAR PATEL
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Highlights of the Year

The year was marked by significant scientific progress, technology validation, and large-scale outreach at SPRERI, reflecting the institute's commitment to advancing renewable energy solutions and enabling sustainable livelihoods. Across its solar energy, bio-conversion, thermo-chemical conversion, hydrogen generation, and extension activities, SPRERI delivered impactful outcomes ranging from pioneering laboratory research to field deployments, commercial technology transfer, national recognition, and strategic partnerships with industry and international collaborators.

In the Solar Energy Division, the institute made substantial strides in decentralized solar refrigeration and solar cooking technologies. The standalone solar-powered refrigerator underwent successful field evaluations at commercial user sites in Anand, demonstrating stable thermal performance, reliable freezing/cooling operations, and tangible income enhancement for rural vendors. A 500-L upscaled solar refrigeration system was developed for fish storage applications, integrating solar PV and a microinverter to support day-long cooling, an important step toward addressing cold-chain challenges in rural markets. Parallely, SPRERI developed an advanced solar PV-based indoor day-night cooking system featuring a fin-optimized phase-change thermal storage module. CFD-based design improvements reduced melting time by 64%, enabling efficient nighttime cooking. The system was further redesigned with AC heating integrated via microinverter to ensure long-term robustness. In solar thermal research, a waste-derived nano-carbon nanofluid was synthesized and characterized for enhanced optical absorption, achieving over 14% higher photothermal efficiency. Essential oil extraction technologies also moved forward, with successful hydro distillation and steam distillation experiments producing yields exceeding reported literature values, and the development of solar concentrator-based extraction systems. The division further installed a walk-in solar tunnel dryer at an organic farm in Anand, reducing drying times by 20% for leafy crops and expanding the farmer's processing capabilities across diverse produce.

The Bio-Conversion Technology Division advanced its work on transforming agricultural residues into high-value biomaterials and biofuels. High-purity microcrystalline cellulose (MCC) was produced from rice straw and banana fiber with high yields, and its crystalline and thermal properties were thoroughly validated. Lignin nanoparticles and cellulose nanocrystals were synthesized using green solvent systems, resulting in nanocomposite films with significantly improved mechanical strength. In algal bioprocessing, dairy wastewater-grown microalgae demonstrated high lipid content suitable for bio-lubricant production, and a dedicated 8-L bio lubricant synthesis workstation was commissioned. The circular economy work on Napier grass revealed that its juice fraction offers excellent biogas yields, leading to successful trials in thermophilic pilot-scale digesters. SPRERI also fabricated and validated a 300-L hybrid horizontal digester, redesigned with an improved screw-feeding mechanism to address mixing challenges. Research on converting raw biogas to methanol progressed with the enrichment of methane-oxidizing bacterial strains and initial serum-bottle-scale methanol production. Work on bio-butanol production also matured through optimized saccharification of cotton stalk biomass and development of pathways to detoxify hydrolysates for improved fermentation.

In the Thermo-Chemical Conversion Technology Division, SPRERI demonstrated production-scale capabilities in biomass gasification, pyrolysis, combustion, and carbon capture. A fluidized bed gasification system successfully generated steam using agricultural residues at costs significantly lower than coal, achieving cold gas efficiencies of 73–74% and reducing potential CO₂ emissions by up to 1,500 tonnes annually for a 1-TPH boiler. A de-scaled down-draft gasification unit was designed for small industries, offering flexible fuel use and reliable operation. In pyrolysis research, the institute processed a variety of

biomass feedstocks at pilot scale, producing bio-oil, biochar, and pyro-gas, and developed new burner configurations capable of stable atomization and combustion of bio-oils at temperatures up to 700 °C. Combustion research focused on pellet burner improvements, where a redesigned grate increased operating time by 50% and formed the basis for a future automated ash-removal system. A notable development was the bio-ash carbon capture study, in which Mg-impregnated biomass ash achieved CO₂ capture rates up to 110 g/kg, with strong economic potential. A pilot-scale ash carbonator was subsequently developed to take this technology closer to field application.

The Hydrogen Generation Group made critical progress in both biological and thermochemical pathways for hydrogen production. Rice-straw-derived sugars were used to produce biohydrogen using an efficient strain of *Staphylococcus epidermidis*, yielding 34 L of hydrogen per kg of rice straw in scaled 5-L reactors. Meanwhile, significant advancements were achieved in the Water Gas Shift Reactor (WGSR) program, with in-house catalysts (iron-, copper-, and nickel-based) showing high conversion efficiencies and enabling hydrogen concentrations of nearly 80% in controlled tests. Integration with a fluidized bed gasifier is planned, paving the way for decentralized biomass-to-hydrogen systems aligned with the National Green Hydrogen Mission.

SPRERI's Extension Division expanded the institute's impact through extensive training, demonstrations, outreach programs, and social development initiatives. More than 200 direct beneficiaries and over 1,500 indirect beneficiaries were reached through cookstove, solar drying, and other technology demonstrations across Gujarat, Uttar Pradesh, Uttarakhand, and West Bengal. A notable deployment included 200 improved cookstoves distributed to the Sundarbans with virtual training sessions. Students from 11 academic institutions, nearly 700 learners visited SPRERI for hands-on exposure to renewable energy technologies. A livelihood-focused DST-supported SUNIL programme was launched, aiming to support nearly 15,000 beneficiaries with socio-economic development integrated with renewable energy technologies. The institute also conducted a women-centric "Banana Waste to Paper" workshop, empowering SHG members with entrepreneurial skills, and organized a large-scale SC community awareness program attended by over 650 participants, where renewable energy assets were distributed. Consultancy and testing services continued to be an important pillar of SPRERI's work.

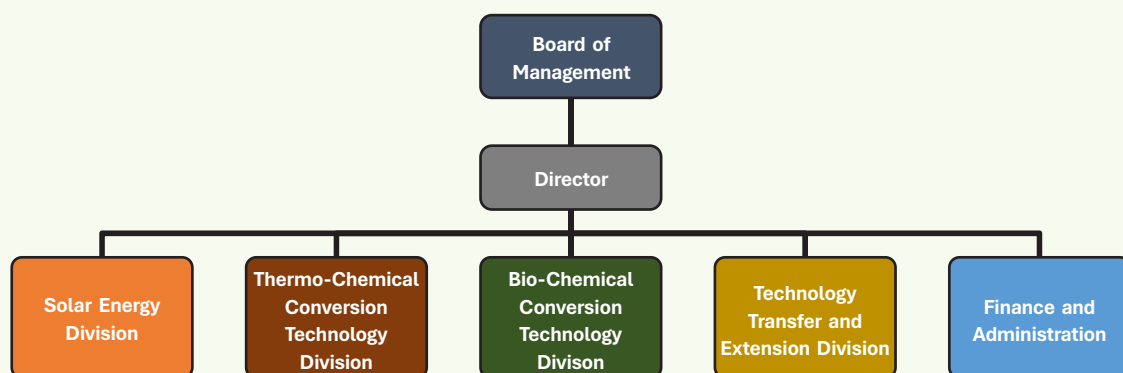
A major consultancy study on PM-KUSUM Component-B, covering 808 off-grid solar pumps across Gujarat, revealed strong economic, environmental, and livelihood benefits highlighting the program as a replicable national model. Multiple analytical services were provided across fuel characterization, gas analysis, cookstove performance testing, and materials analysis. This year also featured important institutional achievements. SPRERI received the Best Centre Award 2024 under ICAR's AICRP on EAAI for outstanding contributions to renewable energy technology development. Staff accomplishments included a Certified Energy Manager recognition for Er. Asim Joshi. SPRERI celebrated its 47th Foundation Day, honoring long-serving staff members and retired employees, reinforcing the institute's strong community ethos. New infrastructure and strategic partnerships strengthened SPRERI's long-term R&D capabilities. A dedicated Hydrogen Laboratory was established with a 3 LPH PEM electrolyzer for detailed electrochemical studies.

The institute signed major MoUs with Axiomex India (Canada), Steelhacks Industries, Chanderpur Works, Encoat Pvt. Ltd., NACOF, and others enabling national and global collaboration and commercialization of SPRERI's technologies. Overall, the year showcased a dynamic blend of scientific innovation, field deployment, community empowerment, and institutional growth. SPRERI's achievements reaffirm its leadership in renewable energy research and its unwavering commitment to building a sustainable, inclusive, and energy-secure future for India.



The Organization & Structure

Sardar Patel Renewable Energy Research Institute (SPRERI), established in 1979, is an autonomous, not-for-profit research organization governed by a Board comprising eminent technologists, scientists, industrialists, and representatives from both Central and State Governments. It is recognized by the Department of Scientific and Industrial Research (DSIR), Government of India, as a Scientific and Industrial Research Organization (SIRO), and is also approved as a Research Association under clause (ii) of sub-section (1) of section 35 of the Income Tax Act, 1961. SPRERI primarily generates its operational funding through merit-based projects awarded by government and non-government entities. These are further supported by service-based activities such as consultancy, technology evaluation, testing, and training, enabling the institute to function in a financially self-sustaining manner. As a nationally reputed research institution in the field of renewable energy, SPRERI is recognized by several universities and academic bodies for postgraduate research. The institute specializes in three core areas: solar energy, bioconversion, and thermochemical conversion of biomass. Numerous renewable energy systems and devices developed at SPRERI have been successfully commercialized and are now manufactured by industrial partners for widespread deployment. In addition to research and development, SPRERI is actively engaged in the promotion and dissemination of renewable energy technologies through field trials, demonstration projects, training and entrepreneurship development programmes, awareness campaigns, and integrated rural development initiatives, particularly in tribal areas.



Vision & Mission

VISION

SPRERI will be an organization that will develop environment friendly Renewable Energy Technologies that are efficient and economically viable for society.

MISSION

To achieve excellence in research, development, and commercial development of renewable energy technologies including education and training for the promotion of environmentally sustainable technologies with public-private cooperation for India and developing global economies.

Board of Management

Chairman

Shri Bhikubhai Patel

Chairman, Charutar Vidya Mandal, Vallabh Vidyanagar, Anand

Members

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Vice-President, Charutar Vidya Mandal, Vallabh Vidyanagar, Anand

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Senior Technical Advisor, Clean Tech Space, Mumbai

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Joint Secretary, Department of Energy & Petrochemicals, Govt of Gujarat, Gandhinagar

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Chief Technical Advisor and Director, CUMMINS Technologies India Limited & Ex-Professor IIT Bombay

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CEO, Bomin Industries Pvt Ltd, Ahmedabad

Mr. Apoorva Oza

Chief Executive, Aga Khan Rural Support Programme, Ahmedabad

Dr. A. Mahesh

Assistant Professor, C. L. Patel Institute of Studies and Research in Renewable Energy, Anand, Gujarat

Member-Secretary

Dr. Anil Kumar Dubey

Director, SPRERI, Vallabh Vidyanagar

1.1 Standalone solar refrigerator for continuous operations

SPRERI undertook field deployment and evaluation of a recently up-scaled standalone solar refrigerator to validate its operation under real-world conditions. The system integrates a DC compressor, powered by a 325 Wp solar PV module, two 12 V-105 Ah batteries, a charge controller, and a programmable timer for optimized energy use. The first field trial was carried out at a retail fish outlet, M/s Abdul Fish Traders in Anand (Figure 1). The system successfully demonstrated freezing of 20 litres of water using only solar energy during daylight hours, with the stored thermal energy maintaining sub-zero temperatures overnight. A subsequent evaluation involved storing 3 kg of Surmayi (Kingfish) at 0 °C over a five-day period. The refrigerator maintained the required temperature band reliably (Figure 2), and fish remained fresh with no signs of spoilage. While acknowledging the system's usefulness, especially in areas without grid access, the user also noted that freezing may not be essential in markets where consumers prefer fresh fish. The field evaluation was also conducted at a grocery store in Bakrol Village, Anand, where the system was used for storing cold beverages and milk over a month-long trial. Initial observations of over-

cooling were resolved by adjusting the temperature set-point to 2 °C. The user expressed satisfaction with the consistent cooling performance (Figure 3). The enhanced storage capability contributed to increased daily earnings of ₹80 – ₹110, translating to an estimated simple payback period of 4.3 to 7.8 years. Following successful validation, the technology was transferred to M/s Steelhacks Industries, Vitthal Udyognagar, through a Memorandum of Agreement signed on March 28, 2025, marking its readiness for commercial uptake.



Figure 1: Refrigerator installed at user site for storing fish



Figure 2: Refrigerator installed at user site for storing milk and cold beverages

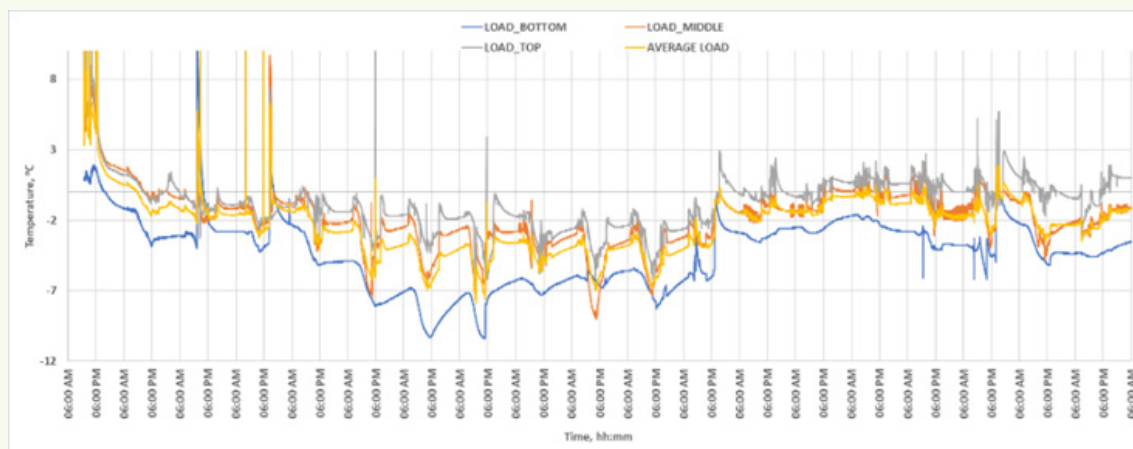


Figure 3: Temperature profile of top, middle and bottom section of loading chamber

1.2 Portable thermal energy storage-based cool chamber for transient storage of fish

Under this project, the SPRERI-developed solar refrigerator was up-scaled (150-200 kg) for fish storage applications. The commercially available deep freezer was modified and integrated with solar PV panel and micro inverter. The set-up is shown in Figure 4.



Figure 4: Up-scaled solar refrigerator of 500 L capacity (a) and Solar PV array for power supply to refrigerator (b)

The detailed specifications of the key components are provided in Table 1. The operation of the refrigerator system on solar power is currently in progress, focusing on evaluating cooling generation performance.

Table 1: Specification of the solar refrigeration components

No.	Item	Specifications
1	Refrigerator (Deep Freezer)	Chamber capacity: 500 L, Compressor: Single-phase, 450 W rating
2	Solar Micro Inverter	Capacity: 0.75 kW
3	PV panel	1.9 kWp



Figure 5: DC heater with TES charging set-up and cooking on induction stove

1.3 Solar PV-based indoor day-night green cooking system

A solar-powered, DC heater-integrated cooking system with latent thermal energy storage was developed to enable reliable night time cooking. The thermal storage module employed a phase change material (PCM), for which the design was systematically optimized using Computational Fluid Dynamics (CFD). The optimized system substantially improves thermal response: the PCM melting time decreased from 9.89 h (un-finned) to 3.55 h (finned), representing a 64% reduction due to enhanced conductive heat transfer pathways. A finned cylindrical stainless-steel thermal storage module was fabricated. To validate system performance under practical solar operation, a PV-powered experimental testbed was developed (Figure 5). Initial trials showed that the insulated DC heater could achieve temperatures up to 1000 °C within 10 minutes. For robust, long-term operation, the heating system was redesigned using an AC heating coil interfaced with the solar PV array through a microinverter, allowing direct AC operation without dependence on battery-stored DC. The final configuration supports two operational modes *viz.* direct solar induction cooking during daytime and PCM-based latent heat cooking during night time using the optimized

thermal storage module. Parallel R&D efforts are focused on synthesizing an advanced nano-enhanced PCM to increase thermal conductivity, improve melt uniformity, and further augment storage efficiency.

1.4 Waste engine oil based Nano fluid for solar thermal applications

A nanofluid with improved optical absorbance and thermal conductivity was developed using nano-carbon (soot) extracted from the filtrate of waste engine oil (WEOF). The nanofluid was prepared using a two-step method with paraffin oil as the base fluid. As shown in Figure 6, six nanofluid samples were formulated with varying WEOF concentrations (3%, 5%, 10%, and 30%)

and different sonication times (15, 30, and 45 minutes) to study the influence on optical properties. The UV-Vis spectroscopy results as shown in Figure 7 (a & b) revealed that increasing the WEOF concentration enhanced visible light absorption, while sonication time had minimal impact on the transmittance spectra.

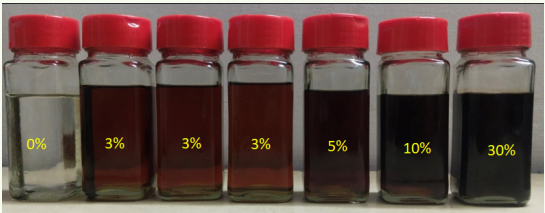


Figure 6: Nanofluid samples prepared at different concentrations

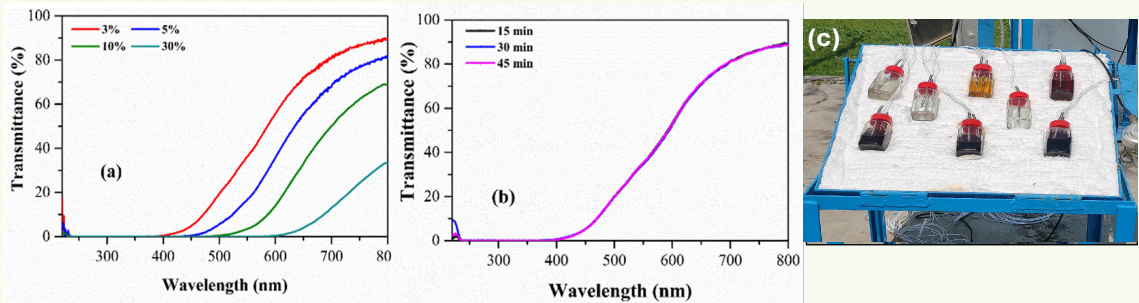


Figure 7: UV-Vis spectra of nanofluid samples (a) different concentrations and (b) different sonication times, (c) Experimental set-up to measure photo-thermal properties

Further, an experimental setup (Figure 7c) was developed to evaluate the photo-thermal conversion efficiency. The nanofluid exhibited optimal photo-thermal performance at 10% WEOF concentration, achieving a 14.1% temperature increase over paraffin oil. Further characterization of the thermal properties of the nanofluid is ongoing.

1.5 Solar thermal systems for essential oil extraction from biomass

The experiments were conducted to extract essential oils from eucalyptus leaves using hydro-distillation and steam distillation techniques. Hydro-distillation of 500 g of leaves yielded 2 g of oil over four hours, corresponding to an oil yield of 0.4%. Steam distillation of 2 kg of leaves yielded 10



Figure 8: Scheffler reflector based essential oil extraction system

g of oil over the same duration, with a total energy consumption of 4.4 kWh, resulting in an oil yield of 0.5%. A parabolic trough-based green steam extraction system was designed and developed for the extraction of high-value aromatic and medicinal products. The system comprises of eight parabolic trough collectors with a total aperture area of approximately 23 m², a 0.3 m diameter extraction unit, a plate heat exchanger featuring ten corrugated plates, a condenser capable of processing 5 kg of biomass per batch. Additionally, a Scheffler reflector-based extraction system was developed and tested as shown in Figure 8. Steam generation experiments were conducted with varying water levels (20 L, 40 L, and 65 L). 20 L of water provided better initial performance. The system improvement for the continuous processing of 5 kg of biomass is in progress.

1.6 Walk-in type solar tunnel dryer at user-site for agricultural produce

A solar walk-in type dryer (7 m × 4.25 m) was successfully installed at the premises of Mr. Devesh Patel, an organic farmer, Boriavi Village, District Anand, Gujarat, under 60:40 cost-sharing model, with the user contributing 60% of the total cost. The installation of this dryer at the user

site is shown in Figure 9 (a). The installed system demonstrated reduced drying time by 20% for leafy crops such as fenugreek compared to traditional open sun drying methods. The dryer has since been effectively used by the farmer for drying a turmeric (Figure 9 (b)), ginger, fenugreek, potato chips, red beet vadi, whole garlic cloves and lemongrass. The user expressed satisfaction with the system's performance and highlighted the significant benefits in terms of quality and efficiency.

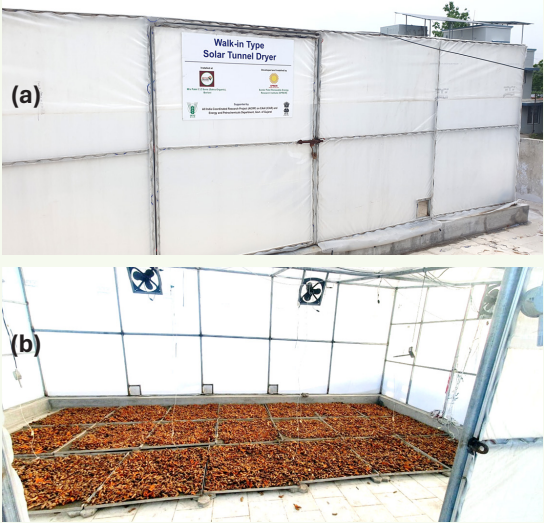


Figure 9: Walk-in-type dryer (a) and turmeric drying (b) at user site

2.1 Development of a sustainable process for production MCC from agricultural residues for industrial application

The extraction of microcrystalline cellulose (MCC) from rice straw and banana fiber was successfully optimized. The yield of MCC from purified cellulose was 84% from rice straw and 73% from banana fiber, indicating efficient recovery through acid hydrolysis. The produced MCC was characterized using X-ray diffraction, Differential Scanning Calorimetry, and Scanning Electron Microscopy. The XRD analysis revealed a higher degree of crystallinity in banana-fiber-derived MCC (80.2%) whereas rice straw-derived MCC showed lower crystallinity (69.9%). The melting temperatures of MCC was 329.2 °C and 324.8 °C and the glass transition temperatures was 85.5 °C and 90.1 °C for rice straw and banana fiber, respectively. Thermal stability of MCC produced from banana fiber and rice straw makes

it suitable for preparation of composites. SEM micrographs (Figures 10 and 11) revealed distinct morphological differences between MCC derived from rice straw and banana fiber. The banana fiber MCC showed coarser rod-like structures with an average diameter of 19.21 µm and lengths from 50 to 150 µm whereas rice straw derived MCC exhibited finer, needle-like particles with a mean diameter of 6.87 µm and lengths between 50 and 250 µm. The banana fiber MCC was more uniform and well-dispersed, with enhanced fibrillation, whereas rice straw MCC showed bundled and compact structures. The surface of both types of MCC are suitable to be used as reinforcement agents in bio-composite films. The Composite films developed using different concentrations of polyvinyl alcohol (PVA) with the addition of 0.5% microcrystalline cellulose (Figure 12). The MCC-reinforced composites demonstrated improved mechanical properties ranges from 10.2% to 100% improvement, confirming the effective reinforcement capability of MCC derived from agro-waste sources.

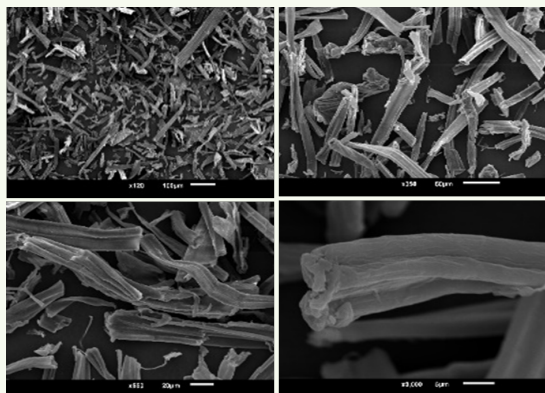


Figure 10: MCC extracted from banana fibre

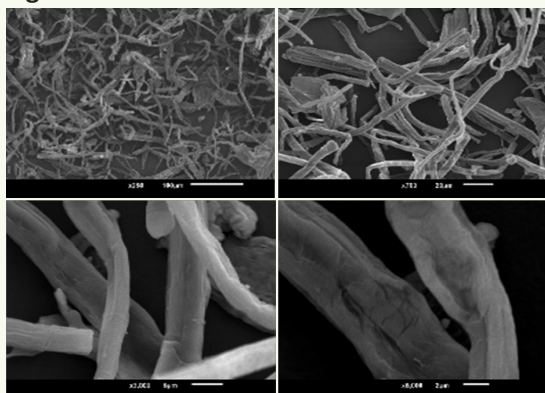


Figure 11: MCC extracted from rice straw



Figure 12: Biocomposites with 0.5% MCC and varying PVA (2.5%, 5%, and 7.5%)

2.2 Development of Cellulose and Lignin based Nano Bio-composites from Agro waste Bio nanocomposite

SPRERI developed lignin and cellulose-based nano-biocomposites films (Figure 13) using polyvinyl alcohol (PVA) with 2.5%, 5%, 7.5%, and

10% concentration mixed with 0.2% of nano-lignin. The tensile strength of nano-biocomposites made from 7.5% PVA was found to be 3.6 times more than the film prepared from PVA alone.

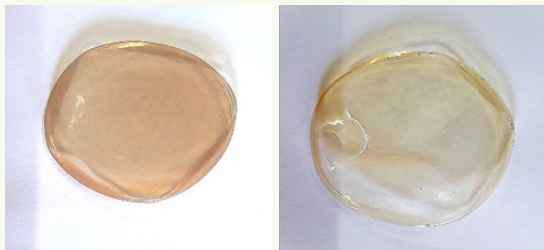


Figure 13: Composite films of lignin nanoparticles in PVA

2.3 Development of Bio-Lubricants from Microalgae derived Lipids

Microalgae grown in waste water was harvested and used for extraction of lipids using hexane and a chloroform–methanol solvent system. For dry microalgae, lipid yields of 50% and 14.9% were obtained using chloroform–methanol and hexane, respectively. In the case of wet microalgae, lipid extraction yields were 17.7% with chloroform–methanol and 5.7% with hexane (Figure 14). Bio-lubricants were synthesized from vegetable oil and microalgal lipids through esterification and transesterification reactions. Lubricant formulations were prepared both with and without

additives, and their physicochemical properties were compared with those of a commercial lubricant. The kinematic viscosity at 40 °C was $3.95 \text{ mm}^2 \text{ s}^{-1}$ for the commercial lubricant and $3.35 \text{ mm}^2 \text{ s}^{-1}$ for the vegetable oil–based lubricant without additives. The addition of additives increased the viscosity to $6.07 \text{ mm}^2 \text{ s}^{-1}$ with trimethylolpropane and $3.89 \text{ mm}^2 \text{ s}^{-1}$ with pentaerythritol. The commercial lubricant exhibited a pour point of $-5 \text{ }^{\circ}\text{C}$, while the synthesized bio-lubricants showed pour points in the range of -2 to $-1 \text{ }^{\circ}\text{C}$. Furthermore, all lubricant samples demonstrated satisfactory oxidative stability, hydrolytic stability, and biodegradability. A laboratory-scale system was developed for the synthesis of bio-lubricants, as illustrated in Figure 15.

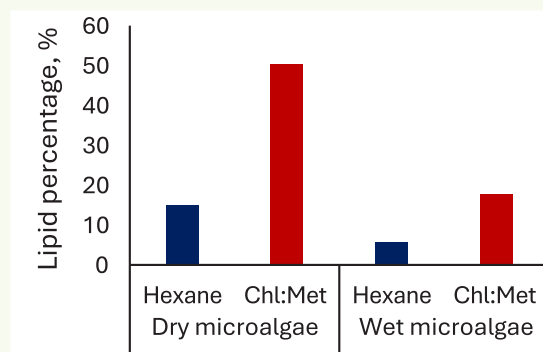


Figure 14: Lipid comparison from dry and wet algal biomass



Figure 15: Bio-lubricant station

2.4 Biomethanation of Napier grass: circular economy approach

The biogas production potential of Napier grass was evaluated in five different forms i.e., raw Napier grass (RNG), de-juiced Napier grass (DNG), Napier grass juice (NGJ), RNG hydrolysate, and DNG hydrolysate. The biomethanation potential of all five feedstock forms was investigated using laboratory-scale anaerobic reactors. The biogas yields (Figure 16) were 88 L kg⁻¹ TS for RNG, 157 L kg⁻¹ TS for DNG, 121 L kg⁻¹ TS for RNG hydrolysate, and 130 L kg⁻¹ TS for DNG hydrolysate. The highest biogas yield was obtained from NGJ, at 290 L kg⁻¹ TS. Pilot-scale studies were conducted in two hybrid anaerobic reactors using Napier grass juice as the substrate. Reactor start-up was carried out at an organic loading rate (OLR) of 2 g L⁻¹, under thermophilic conditions (50 °C). The OLR was gradually increased from 2 to 10 g L⁻¹ at regular intervals once stable biogas production was achieved. In the pilot-scale reactors, a 76%

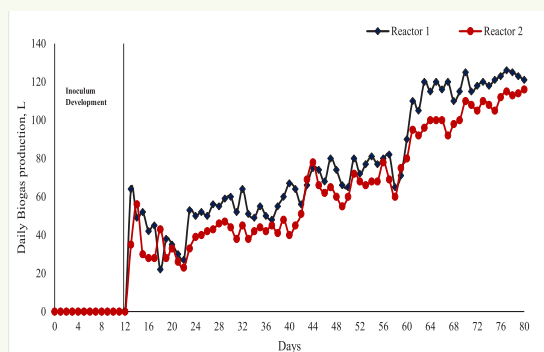
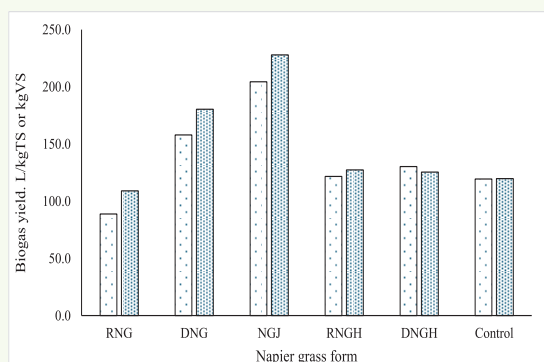


Figure 16: Biogas yield in lab scale (top) and daily production in pilot scale reactors (bottom)

reduction in COD and a biogas yield of 0.43 m³ kg⁻¹ COD were recorded. De-juiced Napier grass was further utilized for pellet preparation, and the resulting Napier grass pellets exhibited a calorific value of 16.3 MJ kg⁻¹.

2.5 Development of a Hybrid Horizontal Flow Anaerobic Digester (HHFAD) for Biogas Production

A horizontal flow anaerobic digester with a capacity of 300 L was designed and developed for a feed rate of 20 kg day⁻¹. The reactor comprised a manual feeding port, slurry outlet, gas outlet, and four impellers intended to facilitate horizontal movement of the feedstock within the reactor. However, the impeller-based configuration was found to be ineffective in achieving adequate mixing of the feedstock. To enhance horizontal transport and mixing efficiency, the system was further modified by incorporating a suitably designed screw mechanism for feedstock movement. The developed horizontal anaerobic digester is shown in Figure 17.

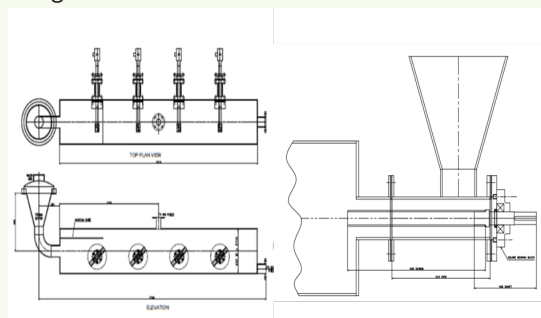


Figure 17: Design of horizontal flow digester and screw feeder (top) and the fabricated digester (bottom)

2.7 Pilot-scale demonstration of bio-methanol production from raw biogas

Methane-oxidizing bacteria (MOB) were isolated and identified as *Methylobaculum buryatense*. Initially, various methanol dehydrogenase (MDH) inhibitors including MgCl_2 , NaCl , EDTA, and sodium formate were evaluated to suppress methanol oxidation by the same strain and thereby enhance methanol accumulation. Subsequently, the methane-to-oxygen ratio and gas purging interval were optimized. Under optimized conditions, methanol production in the range of 160–180 mg L^{-1} was achieved using 20 mM MgCl_2 , an oxygen:methane ratio of 2:1, and purging of the gas mixture every 48 h.

2.8 Pilot scale bio-butanol production from Agri-residue

Bio-butanol production was carried out using *Clostridium sporogenes* cultivated in P1 minimal

medium at 35 °C. Anaerobic conditions were maintained by purging nitrogen gas into 100 mL serum bottles containing the culture and growth medium. Sugar optimization studies were conducted, and hydrolysate was prepared from cotton stalk at 10% (w/v) solid loading. The cotton stalk biomass was pretreated with 2% sulfuric acid at 120 °C for 30 minutes in an autoclave. Enzymatic hydrolysis of the cellulose fraction was subsequently performed using sodium citrate buffer and cellulase (Cellic® CTec2, Novozymes) at a dosage of 12 FPU g^{-1} biomass, under conditions of 50 °C and 150 rpm for 48 h in a shaker incubator. This process resulted in the generation of 50.4 g L^{-1} of reducing sugars. The resulting hydrolysate was used as the carbon source for bio-butanol production. Fermentation experiments conducted in 100 mL serum bottles with an initial glucose concentration of 5 g L^{-1} yielded a butanol concentration of 1.4 g L^{-1} .

3.1 Bio-oil burner for thermal applications

Bio-oil burner of thermal capacity 30,000–50,000 kcal/h for industrial applications was developed and evaluated. The system consists of a bio-oil storage tank with heating & agitation arrangement, a pump for pressurized fuel delivery, atomization nozzle, a cyclone burner, and an air blower (Figure 18). The developed system was tested with bio-oil produced from slow pyrolysis of crop residues such as mustard husk, cotton stalk, banana tree waste and groundnut shell. The bio-oil contains the aqueous phase (5–8%) which was removed by gravity separation and filtration using ASTM-20 sieve. The bio-oil temperature was raised to 55–60 °C to reduce viscosity and enhance the atomization of oil. The satisfactory operation of the bio-oil burner was observed at 40 bar pressure and flow rate of 30–35 LPH (Figure 19). The flame temperature and flame length were

observed to be 600 – 700 °C and 0.9 to 1.2 m, respectively. A system for small enterprises was also developed with reduced fuel flow rate i.e., 8–10 LPH. The low-capacity bio-oil burner shows fluctuating low temperature. The modification of system is in progress.

3.2 Automation of a pellet combustor for high ash-containing pellets

The automation of the existing pellet combustor for continuous and hassle-free operation using



Figure 20: Pellet burner during operation

the high ash-containing pellets was attempted (Figure 20). The existing pellet combustor with high ash-containing pellets shows frequent chock-up of the grate due to the formation of clinkers. It necessitates frequent cleaning of the grate and ash pit for continuous operation. The grate of the existing combustion chamber was modified to address the issue of the free fall of the ash to the ash-pit (Figure 21 a and b). Modified grate enhanced the ash collection into the ash-pit for the initial operating duration. A grate disturbance arrangement, i.e., a paddle (Figure 21 c) was retrofitted into the ash burner to facilitate the increased ash fall. It also avoided the ash accumulation above the grate and eventually delayed the clinker formation on it. Performance of developed system is shown in the Table 2. The reduction in ash accumulation above the grate enhances the continuous



Figure 18: Bio-oil combustion unit and burner with stable flame

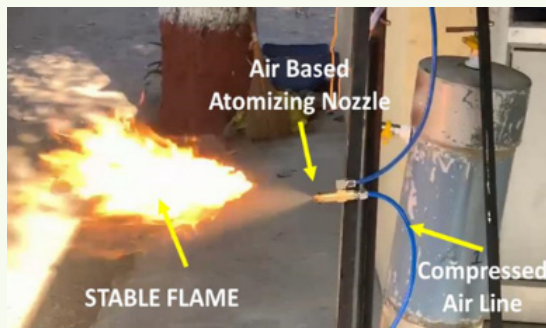


Figure 19: Combustion of bio-oil using an air-atomization nozzle

operational duration of the system by 50%. Further improvements are in progress.

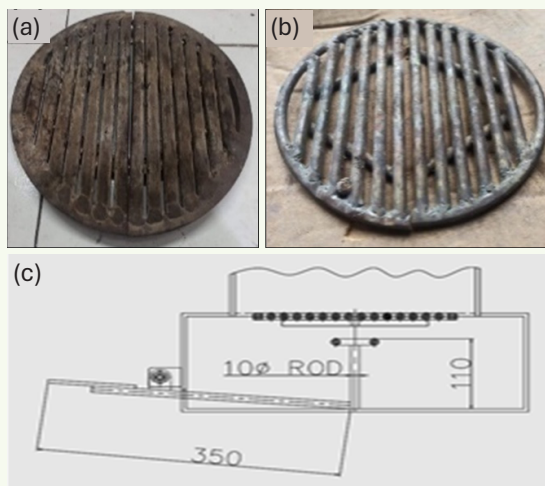


Figure 21: Grate of combustion chamber (a) manufacturer supplied; (b) in-house modified and (c) schematic of lever-operated mechanism

Table 2: Performance parameter of modified grate with pellets

Performance Parameter	Commercial pellets before and after modification		Torrefied pellets before and after modification	
	Before	After	Before	After
Feed (kg)	100	150	52	70
Operation time (h)	4	6	2.25	3
Ash recovery from grate (Fused) (% of feed)	8.7	7.9	19.2	17.2
Ash recovery from tray (% of feed)	Nil	0.2	Nil	0.5
Percentage increase in time	50.0		33.3	

3.3 Feasibility study on CO₂ mineralization using biomass-ash: A carbon capture and sequestration (CCS) approach

A feasibility study has been conducted for the mineralization of CO₂ with bio ash as a carbon

capture strategy. Ash samples of locally available groundnut shell, sawdust, and cotton stalks from improved cookstove was collected. Bio ash has shown the potential to capture 180 g CO₂/kg ash which could be further increased to 226 g CO₂/kg ash after impregnating ash with 20% magnesium chloride hexahydrate. The experiments were conducted in a bench-scale reactor (0.7 L capacity) at 4 bar pressure and 90 °C (Figure 22 a & b). The ash from groundnut shell and cotton stalk exhibited CO₂ capture capacities of 110 g/kg and 103 g/kg ash, respectively, equivalent to 55–60 L of CO₂ per kilogram of impregnated ash. Post-carbonation analysis revealed mineral content of CaCO₃, MgCO₃ and K₂O. A pilot-scale biogas based carbon capture system was developed. The developed system has the processing capacity of 2 kg of ash per batch of operation to absorb-100 L of CO₂ (Figure 22 c).

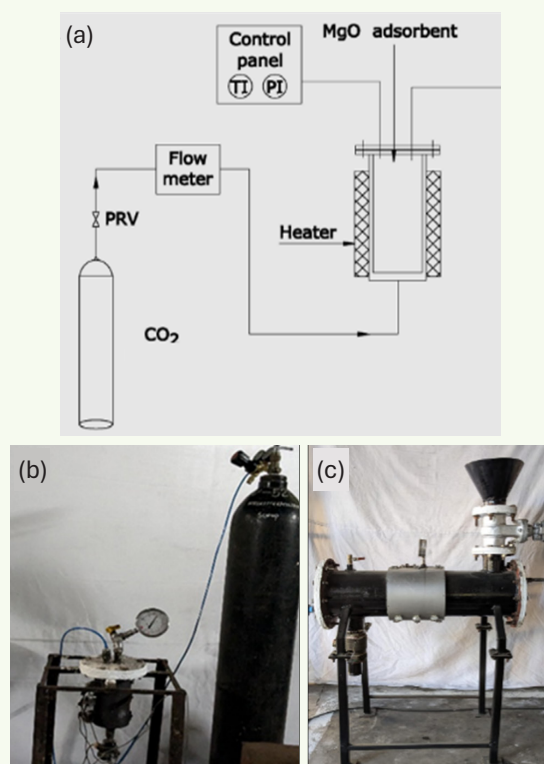


Figure 22: CCS for CO₂ mineralization (a) Schematic of the reactor; (b) bench scale experimental set-up and (c) pilot scale set-up of capacity 2 kg/batch

3.4 Multi-fuel Down-draft gasification system for micro and small businesses

A down-draft gasification system suitable for micro and small-scale commercial system has been developed for thermal applications having capacity of 50,000–1,00,000 kcal/h. The system consists of a reactor, a blower, a cyclone separator, a cooling seal, and a control panel for controlling the blower speed and gas flow (Figure 23). The developed system has been evaluated using the wood blocks, charcoal of babool, and bio-briquettes (75 mm) as a fuel. The gasification efficiency was found in the range of 68–71% at the optimized parameters. The developed system is equipped with a butterfly valve and the VFD-operated blower for the precise control of output gas suitable for end applications.



Figure 23: Down-draft gasification system (capacity 15 kg/h) operated on charcoal of babool

4.1 Bio-hydrogen production from rice straw

Three strains were identified: *Staphylococcus epidermidis*, *Shigella flexneri*, and *Enterobacter cloacae*. The study focused on optimizing hydrogen production using *Staphylococcus epidermidis* SPS3 in both controlled and up-scaled fermentation systems. Initial hydrogen production was conducted in 300 mL reactors, followed by scale-up experiments in 5 L anaerobic reactor (Figure 24). The hydrogen production in up-scaled reactor (5 L capacity) was observed to be 150 L/kg of sugar using the SPS3 strain, with a yield of 1.2 mol/mol of glucose. Alkali pre-treated rice straw was enzymatically hydrolysed using Cellic® CTec2 yielding 52 g/L of fermentable sugars that served as substrates for dark fermentation. The rice straw hydrolysate produced 34 L of hydrogen per kg of rice straw using *Staphylococcus epidermidis* SPS3 strain.



Figure 24: Bio-hydrogen production reactor (5L capacity)

4.2 Bio-hydrogen production using water gas shift reactor

The process parameters of water gas shift reactor were refined, a two-stage reactor configuration

(Figure 25) was evaluated with inhouse developed metal-based catalysts (Figure 26). Iron-based catalyst was developed for the high-temperature shift reactor (400–500 °C) while copper-based catalyst was tailored for the low-temperature shift reactor (200–300 °C) to maximize CO conversion and minimize the reverse reaction. The steam-to-gas ratio was optimized using a controlled mixture of pure CO and steam. The CO conversion of 80% was achieved in the gas flow stream. The developed WGSR was integrated with fluidized bed gasifier (FBG) for conversion of CO present in the producer gas into hydrogen via. shift reaction.



Figure 25: Integrated WGSR and fluidized bed gasifier for enhanced Hydrogen production via biomass gasification

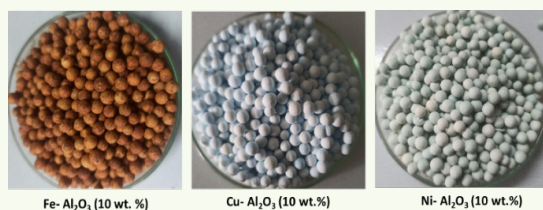


Figure 26: In-house developed catalysts for application in WGSR

5.1 Demonstration, Training and Awareness Creation Program

The Demonstration, Training, and Awareness Program for the year was successfully conducted in a hybrid mode combining both physical and online platforms to ensure wider accessibility and active participation of farmers, academia, and industry representatives. The initiative covered diverse geographic regions including multiple locations within Gujarat as well as areas outside the state, thereby extending its reach and impact. The physical sessions facilitated hands-on engagement and direct interaction while the online modules enabled participation from remote locations overcoming logistical challenges. This blended format allowed flexibility in delivery and ensured that the program could accommodate a wide range of participants, effectively enhancing knowledge dissemination and stakeholder engagement across different regions. The visuals of the demonstration conducted are shown in Figure 27.



Figure 27: Demonstration of the SPERITECH cookstove across different regions

Demonstration in Gujarat

Demonstration of the SPERITECH Improved Biomass Cookstove and Micro Solar Dome was conducted in a special community engagement event organized by the Foundation for Ecological Security (FES) on March 8, 2025 during the celebration of International Women's Day. The event took place at Maharaj na Muvada village of Kheda district (Figure 28). These demonstrations held at a dedicated FES stall aimed to raise

awareness about clean and sustainable energy alternatives for cooking among the rural community. The event witnessed active participation of more than 500 women along with the village Sarpanch and representatives from the District Level Management (DLM), underscoring a shared commitment to sustainable development and the empowerment of women in rural areas. Similarly, Improved Biomass Cookstove demonstrations were conducted in Mujkva, Anand on September 12, 2024 and Mahemdabad, Kheda on January 8, 2025. The demonstrations aimed to educate local communities on cleaner cooking solutions, promoting energy efficiency and reducing indoor air pollution.



Figure 28: Demonstration of SPERITECH cookstove at Bhadrasa, Kheda

Cookstove Deployment and Virtual Training

SPERITECH cookstoves (200 Nos.) were sent to the Vivekanand Institute of Biotechnology (VIB) located in the Sundarbans region of West Bengal (Figure 29). An interactive virtual demonstration and discussion session was conducted on March 20, 2025 that focused on its key features and benefits. The training was attended by technical

team of VIB and selected beneficiaries encouraging adoption of the technology.



Figure 29: Virtual demonstration of SPRERITECH cookstove

Demonstrations outside Gujarat

Demonstration of SPRERITECH cookstove was conducted for the participants of Udyami Mela organized by Tap Rise at Jhansi, Uttar Pradesh, from February 19 – 21, 2025 (Figure 30). The Udyami Mela aimed to empower rural enterprises by connecting them with technology providers, innovators, and entrepreneurs, and to promote the adoption of sustainable clean and advanced technologies. The biomass cookstove was also demonstrated by SPRERI at HNB Garhwal University, Uttarakhand, on March 24, 2025. The participants included students, faculty members, and local people. The demonstration highlighted the importance of sustainable cooking solutions in energy efficiency and environmental conservation.



Figure 30: SPRERITECH cookstove demonstration at Jhansi

Demonstration for students conducted at SPRERI

SPRERI conducts technology demonstrations for school and college students throughout the year. These students are given the opportunity to visit SPRERI technologies, gaining insights into the ongoing research and development in the field of renewable energy. A comprehensive list of the colleges that have visited the institute during the year is given in Table 3.

Table 3: List of school/college visited SPRERI

Sr. No.	Name of School/College	Date	No. of students	Students
1	College of Agriculture, AAU, Jabugam	15/04/2024	57	B. Sc. (2 nd Year)
2	A.D. Patel Institute of Technology, Anand	15/07/2024	38	EC, Electric and Mechanical Engg.- (4 th Year)
3	BBIT, CVM, Anand	02/08/2024	60	Diploma in Comp. Engg/IT
4	I.B. Patel School, Anand	13/08/2024	115	6,7, & 8 Std.
5	Engineering College, Tuwa	09/09/2024	120	Diploma Mechanical Engineering

Sr. No.	Name of School/College	Date	No. of students	Students
6	BBIT, CVM, Anand	26/09/2024	75	Diploma Mechanical & Electrical Engineering
7	Gyanganga Vidyalaya, Mogri, Anand	25/11/2024	150	4,5 & 6 Std.
8	Christian College of Education, Anand	16/12/2024	45	B.Ed, Trainee (2 nd Year)
9	St. Xavier's High School, Anand	21/12/2024	115	Grades 4, 5 & 6
10	Polytechnic Agricultural Engineering, NAU, Dediapada, Narmada	23/12/2024	20	Final year diploma Agri. Engg.
11	College of Agricultural Engineering and Technology, NAU, Navasari	20/01/2025	20	Agri. Engg. (4 th Year)

5.2 Research Demonstrations under DST-SUNIL programme

Technology Interventions to Strengthen Livelihood Generation for EWS in Selected Areas of Gujarat

The project is designed with a community-centric, livelihood-oriented approach, aiming to benefit economically weaker sections (EWS) across four districts of Gujarat. It integrates research and development components to upscale and

retrofitting of SPRERI technologies at the community level. A socio-economic survey has been initiated to assess the current status and readiness for the adoption of RE technologies. The questionnaire has been developed using the Kuppuswamy scale and is being administered through the Kobo Toolbox platform. The identified interventions for implementation in field and their expected output and outcomes are given in Figure 31.



Figure 31: Project at a glance

5.3 Composting of Banana Pseudostem and Rice Straw with SPRERITECH Consortia

The study was conducted to reduce the composting duration using SPRERITECH consortia for Rice Straw (RS), Banana Pseudostem (BS), and their combinations. Five different treatments were selected for the study i.e. 100:0; 75:25; 50:50; and 25:75 in the ratio of Banana Pseudostem (BS): Rice Straw (RS). The SPRERITECH consortia was prepared and inoculated with the samples selected

for the study. The SoP developed by SPRERI for making the compost from agro residues was followed for preparation of compost from selected samples. Throughout the experiment, parameters such as total solid, volatile solid, and moisture content were measured at 7-day intervals. The results of all treatments indicate that all samples reached the composting stage after 21 days, as shown in Table 4. The NPK of selected samples are given in Table 5.

Table 4: Data of TS, VS and MC on 1st and 21st day of composting

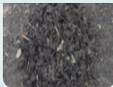
	100% Rice straw (RS)	100% Banana Pseudostem (BS)	50% RS and 50% BS	25% RS and 75% BS	75% RS and 25% BS
					
TS (%)					
Day-1	49	37	32	38	52
Day-21	25	30	30	23	21
VS (%)					
Day-1	42	82	87	76	50
Day-21	66	85	48	39	64
Moisture Content (%)					
Day-1	50	62	67	61	47
Day-21	74	69	69	76	78

Table 5: NPK analysis of prepared sample (Present Study)

Sample Names	Parameters		
	N	P	K
100 % Rice Straw	0.62	0.78	0.84
100 % Banana	0.12	0.32	0.46
50% Rice Straw + 50% Banana	0.41	0.46	0.47

5.4 Energy Assessment of Banana Production in Gujarat

Banana is an annual crop that requires a significant amount of energy throughout its lifecycle. Energy consumption in different agricultural operations for banana production includes seedbed preparation, tillage, sowing, fertilization and pest control, irrigation, harvesting, and transportation. In Gujarat, there are 8 Agro-Climatic Zones (ACZs), of which five are suitable for banana cultivation.

Based on the ICAR-AICRP sampling methodology, the number of villages selected from these five ACZs was determined according to the area under banana cultivation. A sample of 30 villages was selected from major banana-producing areas with 20 eligible farm households chosen from each village. In total, 600 farm households were surveyed for energy auditing in banana cultivation across Gujarat. The data collection process for this study was facilitated using KoboToolbox. The

survey covered 120 banana farmers from Anand district. Figure 32 shows the representative picture of meeting with farmers during the survey. The total energy consumed in various agricultural operations was calculated and expressed in energy equivalents. The impact of farmer landholding on energy consumption pattern increases with the increase in landholding size, as shown in Figure 33.



Figure 32: Meeting with farmers during survey

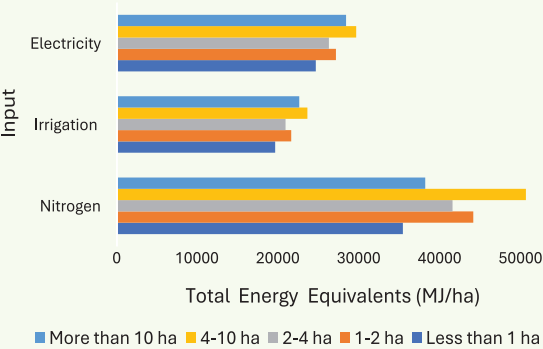


Figure 33: Energy input in major activities of banana cultivation

5.5 Banana Waste to Paper: Crafting an Eco-friendly Future

Skill-building workshop titled “Banana Waste to Paper – Crafting an Eco-Friendly Future” was organized on March 10-11, 2025 at SPRERI. About 30 women participated in workshop. 15 women were from Roshani Sakhi Mandal from Agas village, Petlad taluka, Anand. The other set of 15 women was from Vikash Mission Mangalam, a SC community SHG, Anand. The workshop focused on building practical skills, promoting environmental conservation, and creating livelihood opportunities by transforming agricultural waste into eco-friendly paper products (Figure 34). The initiative offered hands on skill and live demonstration to make different types of paper, such as: paper with banana fiber, paper with banana pseudostem, paper with fragrance, etc.

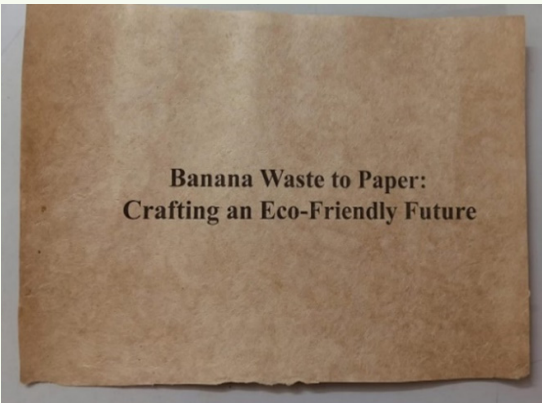


Figure 34: Workshop expert with participants (Left); Paper made from banana waste (right)

5.6 Empowering SC Community through Renewable Energy Interventions in Gujarat

One-day event titled “Empowering SC Community through Renewable Energy Interventions in Gujarat” on March 21, 2025 by SPRERI, supported by ICAR-AICRP on EAAI (SCSP). The event was graced by eminent dignitaries: Mr Yogesh Patel, MLA, Anand; Ms Devahuti (IAS), DDO, Anand; Dr V. K. Bhargava, Project Coordinator, ICAR-AICRP on EAAI, Bhopal; Er Bhikhubhai B. Patel, Chairman, CVM & SPRERI,

Anand. The program witnessed an enthusiastic participation of over 650 attendees (SC women of Anand and Kheda districts (Figure 35). National Rural Livelihoods Mission, Anand, supported the event to reach out to the SC beneficiaries. During the event, technology grant certificates for solar double-glazed small portable dryers, a solar refrigerator system, a community-size cookstove, and household cookstoves were disseminated to identified beneficiaries.



Figure 35: Pictures of the event and technology certificate distribution

Open House

SPRERI organized its flagship event, the 16th Open House on January 28-29, 2025 with the objective of spreading awareness and knowledge about various renewable energy technologies among diverse sections of society. The event witnessed participation from farmers, students, entrepreneurs, researchers, business professionals, and the general public, creating a vibrant platform for information exchange and technology demonstration. Dr M. Shyam former

Director of SPRERI, was Chief Guest of the event. Mr Sydney Lobo, Board Member, SPRERI, Er. Shri Bhikubhai Patel, Chairman, CVM University and SPRERI Board Member, chaired the function (Figure 36). The distinguished guest visited the technologies exhibited for Open House. Following the dignitaries visit, the event was declared open for participants. The event saw an overwhelming response with more than 2,800 visitors in two days.



Figure 36: Glimpse of the Open House

6.1 Consultancy Services

Impact Analysis and Performance Monitoring of off-grid Solar Water Pumps Under Component-B of PM KUSUM Scheme

SPRERI, in collaboration with DGVCL, evaluated 808 off-grid solar water pumps across 31 districts of Gujarat under PM-KUSUM Component-B (Figure 37). The study found strong technical performance (6.5–8.3 h/day operation), full compliance with MNRE/GoG norms, and major benefits including 2.82 million kWh annual energy savings and 2,324 tCO₂ reduction. The scheme offers high economic returns (>80% IRR, ~3-years payback) and significant socio-economic gains for farmers. Gujarat's PM-KUSUM implementation presents a scalable, replicable model for clean and decentralized agricultural energy.



Figure 37: Draft report submitted to DGVCL

Biomass Availability Assessment for Western Region (Gujarat, Maharashtra, Madhya Pradesh, and Rajasthan)

The Thermo-Chemical Conversion Division at SPRERI, in collaboration with Saint Gobain, conducted a study titled “Biofuel Availability Assessment for Western Region (Figure 38). This study aimed to find out the availability pellets and

briquettes manufacturers in Gujarat, Maharashtra, Madhya Pradesh, and Rajasthan, which can be used as a cleaner and more sustainable energy source for thermal energy needs.



Figure 38: Report on biomass availability assessment for western region

6.2 Testing Services

- Fuel (Physical form: Gel) characterization in terms of calorific value, KOKO Networks Pvt. Ltd., Gandhinagar, Gujarat.
- Gas chromatograph (GC) for gaseous fuels, VGEC, Ahmedabad, Gujarat.
- Biomass compositions (cellulose, hemicellulose and lignin) for crop residues for PhD student, Rahul Kumar Thakur, GEER Foundation, Gandhinagar, Gujarat.
- Cookstove emission and efficiency testing, Yashwant Scientific Industries, Satara, Maharashtra.
- Analysis of the biogas for the Ph.D. Student, Mr. Madhusudan Barot, Ahmedabad, Gujarat.
- Differential Scanning Calorimetry analysis of the phase change material for the Ph.D. student, Mr. Jwalant Trivedi, G. H. Patel College of Engineering and Technology, Vallabh Vidyanagar, Anand, Gujarat

7.1 National seminar on green hydrogen

The Sardar Patel Renewable Energy Research Institute, with the support of the Gujarat State Biotechnology Mission (GSBTM), has organized a one-day National Seminar on “Opportunities and Challenges in the Production of Green Hydrogen from Biomass,” on December 14, 2024, at SPRERI. This seminar was attended by 80 participants from universities, institutes and industries. The National

seminar was inaugurated by Dr K. B. Kathiria, Vice Chancellor, Anand Agricultural University. Dr Sunil Kumar Khare, director, IISER Kolkata was the guest of honor and key note speaker. Dr Bhargava, project coordinator, AICRP on EAAI and Dr Sandip Gangil, Project Coordinator, CRP on EA, Dr Manish Das, Director, ICAR-DMAPR were the distinguished guest. The glimpses of event are shown in Figure 39.



Figure 39: Glimpses of the National Seminar

During the day, two technical sessions, a panel discussion and valedictory function was held. The technical Session-I on ‘Hydrogen Generation Pathways from Biomass’ was chaired by Prof. S. K. Khare and Co-Chaired Dr Sandip Gangil. During the session the presentations was made by Dr Sandip Mandal, Dr Shyamali Sarma and Er Sudarshan Suryawanshi. The technical session II on ‘Challenges and future perspectives of green hydrogen economy’ was chaired by Dr C. K. Sumesh and Co-Chaired Dr V. K Bhargava & Dr Anil K. Dubey. In this session five speakers namely, Dr

P. Subramanian, Dr G. Mohanakrishna, Dr Mukund Adsul, Dr Sandip Gangil, and S. Satish made their presentation. After each session question-answer session was organized in which speakers answered the questions raised by participants. The panel discussion was chaired by Dr P. Subramanian (TNAU) and other fellow panelists were Dr V. K. Bhargava (ICAR-CIAE), Dr Sandip Gangil (ICAR-CIAE), Dr C. K. Sumesh (CHARUSAT) and Dr Shyamali Sarma (iFOREST). This discussion was moderated by Dr Mukul Dubey (SPRERI). The discussion was held on pathways of hydrogen

production, policies and support by government, reduction in production cost, challenges and opportunities in bio-hydrogen generation, storage and transport. The seminar ended with concluding remarks by Prof. S. K. Khare, Dr Anil Kumar Dubey, Director SPRERI and Dr A. Mahesh (C. L. Patel ISRRE). Key recommendations from this seminar are- i) Develop robust policies and financial incentives to promote research and production of green hydrogen from biomass, ii) Invest in R&D for efficient and cost-effective biomass conversion technologies, iii) Establish clear guidelines for biomass collection, transportation, and conversion to streamline operations and reduce costs, iv) Encourage collaborative projects between academia, industry, and government to innovate in hydrogen production methods. The event also received media coverage (Figure 40).

7.2 The 47th Foundation Day Celebration of SPRERI

The Sardar Patel Renewable Energy Research Institute (SPRERI) proudly marked its 47th Foundation Day on January 27, 2025,



Figure 41: Glimpses of the 48th foundation day celebration of the SPRERI



Figure 40: Media coverage of the event

commemorating over four decades of pioneering work in the field of renewable energy. Established on January 27, 1979, by the visionary Dr H. M. Patel, former Home Minister of India, and Shri Nanubhai Amin, a renowned industrialist and



social worker, SPRERI has remained at the forefront of sustainable innovation. The foundation day celebrations featured a series of engaging activities that highlighted the institute's remarkable journey and achievements. The glimpses of the event are given in Figure 41.

A key segment of the event included a special recognition ceremony honoring current scientific staff members who have completed 10 years of dedicated service, and technical and support staff who have served SPRERI for 15 years. In addition, the institute paid tribute to its retired employees who have superannuated, acknowledging their invaluable contributions to SPRERI's legacy. The celebration reflected the institute's strong community spirit, with participation from current and retired staff. The event was chaired by Shri Bhikhubhai B. Patel, Honorable Chairman of the SPRERI Board, and was further graced by the presence of Mr. Sydney Lobo, esteemed board member of SPRERI and Dr Murari Shyam, former Director of SPRERI. The Director of SPRERI hosted the celebration and warmly welcomed all guests, setting a tone of gratitude and inspiration for the day. The 47th foundation day served not only as a celebration of the institute's rich history but also as a reaffirmation of its commitment to advancing renewable energy research and development in India.

7.3 Poster Competition

SPRERI organized a poster competition for undergraduate students, centered on the theme "Clean and Green Energy for Sustainable Development" aimed at encouraging young minds passionate about science and renewable energy, invitations were extended to various colleges and academic institutions to participate. The enthusiastic response led to a diverse collection of innovative and thought-provoking posters. Held on February 28, 2024, the event featured 25 participants who presented creative ideas and research-driven insights. The posters were evaluated by two external judges (Figure 42) based on predefined criteria, and prizes were awarded

to the top three entries along with a consolation prize. The competition was a resounding success, reflecting the creativity, awareness, and commitment of the students toward promoting sustainable energy solutions.



Figure 42: Poster evaluation during the session

7.4 Essay Competition

Essay competition for students of classes 8 to 12 was organized on the topic "The Importance of Renewable Energy in Our Daily Life." The initiative aimed to raise awareness among young minds about sustainable energy practices and their role in shaping a greener future. A total of 45 students from various schools enthusiastically participated (Figure 43), showcasing their understanding, creativity, and perspectives on how renewable energy can positively impact everyday living. The essays were judged by a panel based on content, originality, and relevance to the theme. The top three entries were awarded prizes, along with a consolation prize, in recognition of their outstanding efforts. The competition not only encouraged students to think critically about energy sustainability but also highlighted their passion and potential as future champions of clean energy.



Figure 43: Student participants in the event

8.1 Hydrogen Laboratory

To further strengthen its capabilities in the field of green hydrogen research and development, SPRERI has initiated a significant addition to its infrastructure by procuring a Proton Exchange Membrane (PEM) electrolyzer system (Figure 44) with a hydrogen generation capacity of 3 liters per hour (LPH). This initiative marks a strategic step toward establishing a state-of-the-art experimental facility focused on advancing the science and engineering of renewable hydrogen production technologies. The primary objective of this facility is to facilitate in-depth research into the operational behavior and performance characteristics of PEM electrolyzers under various controlled conditions. The system will support rigorous investigations into a range of critical parameters including cell voltage dynamics, current density optimization, Faradaic efficiency, and water and thermal management strategies. Through systematic experimentation, the facility will also enable studies on long-term operational stability, degradation mechanisms, and durability of membrane electrode assemblies (MEAs). This initiative is aligned with SPRERI's broader goal of promoting technological innovation

and localization in the hydrogen value chain. The data and insights generated will inform optimization strategies for system design, integration with renewable power sources (such as solar PV), and scale-up for decentralized and industrial applications. Furthermore, the facility will serve as a training and demonstration platform for academic researchers, industry partners, and government stakeholders, thereby contributing to capacity building and fostering collaborations in the green hydrogen ecosystem. Overall, the establishment of this PEM electrolyzer facility reinforces SPRERI's commitment to supporting India's National Hydrogen Mission and accelerating the transition toward a low-carbon, energy-secure future.

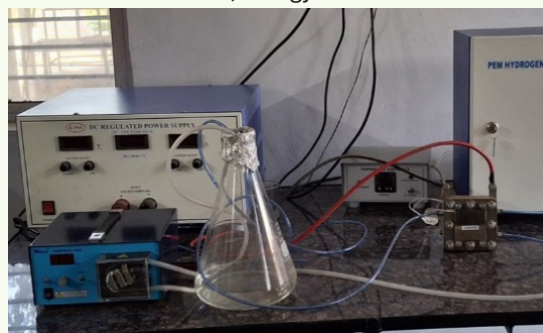


Figure 44: PEM electrolyzer installed in Hydrogen Laboratory

Memorandum of Understanding/Agreements

1. MoU between M/s Steelhacks Industries, Vitthal Udyognagar and SPRERI

On March 28, 2025, SPRERI signed a Memorandum of Agreement (MoA) with M/s Steel Hacks Industries, Vitthal Udyognagar, Anand, Gujarat, (Figure 45) for the non-exclusive transfer of four renewable energy technologies—two related to solar drying and two to solar refrigeration. SPRERI developed these technologies under the All India Coordinated Research Project on Energy in Agriculture and Agro-based Industries (AICRP on EAAI), funded by the Indian Council of Agricultural Research (ICAR). The agreement aims to facilitate the commercialization of these technologies,



Figure 45: MoU signing ceremony between M/s Steelhacks Industries and SPRERI

providing sustainable and cost-effective energy solutions for farmers, small enterprises, and rural communities. This collaboration underscores

SPRERI's commitment to technology dissemination and industry engagement to accelerate the adoption of renewable energy innovations.

2. MoU between Axiomex India Pvt. Ltd., Delhi - a subsidiary of Canada's Axiom Group and SPRERI.

On February 14, 2025, SPRERI signed a Memorandum of Understanding (MoU) with Axiomex India Pvt. Ltd., Delhi—a subsidiary of Axiom Group, Saskatchewan, Canada—at the Canadian High Commission, Chanakyapuri, New Delhi (Figure 46). The signing ceremony was graced by the Honourable Daryl Harrison, Minister for Agriculture, Government of Saskatchewan. The MoU focuses on collaborative research, development, and technology sharing in the field of biomass-based hydrogen generation. As part of this partnership, SPRERI and Axiomex will jointly work on the Agri-Energy Nexus, with a focus on hydrogen production from energy crops and other renewable technologies. This initiative will also involve collaboration with the Agency for New and Renewable Energy Technology (ANERT), an undertaking of the Government of Kerala, which has been selected for the Hydrogen Valley Innovation Cluster by the Department of Science and Technology (DST), Government of India.



Figure 46: MoU signing ceremony between Axiomex India Pvt Ltd and SPRERI

3. MoU between M/s Chanderpur Works Pvt. Ltd (CWPL), Haryana and SPRERI

SPRERI signed a Memorandum of Agreement (MoA) with M/s Chanderpur Works Pvt. Ltd. (CWPL), Haryana, (Figure 47) for the transfer of two innovative technologies developed by the

Institute: The Fluidized Bed Gasification System and the Biochar Production / Torrefaction System. The agreement was formalized through the signing by the Directors of both organizations. This collaboration aims to enable the effective commercialization and large-scale deployment of these technologies, promoting sustainable energy solutions across industrial and agricultural sectors. The partnership highlights SPRERI's continued efforts to bridge research with real-world impact through industry engagement.



Figure 47: MoU signing ceremony between M/s Chanderpur Works Pvt Ltd and SPRERI

4. M/s Encoat Pvt. Ltd., Pune, Maharashtra and SPRERI

On March 27, 2025, SPRERI entered into a Memorandum of Agreement (MoA) with M/s Encoat Private Limited, Pune, (Figure 48) for the transfer of the SPRERITECH technology—



Figure 48: MoU signing ceremony between M/s Encoat Pvt Ltd and SPRERI

Improved Biomass Cookstoves (IBCs), specifically the domestic model NDSL-190. This technology was developed by SPRERI with support from the All India Coordinated Research Project on Energy in Agriculture and Agro-based Industries (AICRP

on EAAI), under the Indian Council of Agricultural Research (ICAR). The partnership aims to promote eco-friendly and efficient cooking solutions for both rural and urban households, contributing to reduced environmental impact and improved energy access. This agreement reinforces SPRERI's commitment to scaling sustainable technologies through industrial collaboration.

5. MoU between NACOF and SPRERI

On August 2, 2024, SPRERI formalized a Technology Transfer Agreement with the National Federation of Farmers' Procurement, Processing and Retailing Cooperatives of India Ltd. (NACOF), New Delhi (Figure 49). Under this agreement, NACOF has been appointed as the official marketing and



Figure 49: MoU signing ceremony between NACOF and SPRERI

implementation partner for two key renewable energy technologies developed by SPRERI: the 3.5 m³ Bio-Methanation System and the Improved Biomass Cookstove. This partnership is aimed at facilitating the large-scale dissemination of these technologies through NACOF's extensive cooperative network across India. It also supports national objectives for clean energy transition, rural energy access, and livelihood enhancement by integrating renewable energy solutions into community-based systems.

6. Sankhya Capital LLC for marketing of SPRERI technologies

SPRERI and Sankhya Capital LLC entered into a Memorandum of Understanding on February 2, 2025 to collaborate in strengthening the marketing and outreach of SPRERI's renewable energy technologies. Under this partnership, Sankhya Capital LLC will provide strategic marketing intelligence, including market trends, competitive insights, and potential stakeholder linkages, to enhance the visibility and adoption of SPRERI technologies. SPRERI will provide technical support and help with market assessment. This partnership will promote the technologies and identify commercial opportunities for wider use.

Recognition & Achievements

Best Center Award

SPRERI was honored with the Best Centre Award for year 2024 (Figure 50) at the XXVIII Annual Workshop of the All India Coordinated Research Project on Energy in Agriculture and Agro-based Industries (AICRP on EAAI), held from February 25–27, 2025, at Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra. This prestigious recognition, conferred by the Indian Council of Agricultural Research (ICAR), acknowledges SPRERI's outstanding contributions in the field of Developing Renewable Energy Technologies (DRET). The award reflects the collective efforts and dedication of SPRERI's Chairman, Board Members, Directors, and staff.



Figure 50: Certificate for the Best Centre Award-2024 conferred by ICAR-AICRP

Certified Energy Manager Award

Er Asim Joshi, achieved certification of Energy Manager from the Bureau of Energy Efficiency (BEE)

on March 21, 2025 with registration no.19485/T. A Bureau of Energy Efficiency (BEE) Certified Energy Manager (CEM) is an individual who possesses qualifications under the Energy Conservation Act (2001) and plays a crucial role in optimizing an

organization's energy use, developing strategies to reduce consumption, and promoting sustainability while also ensuring compliance with environmental regulations and standards.

Publications

- Singh R.K., Soni B., Patel U., Joshi A. K., and Patel S. K. S., (2025). “*Boosted Bio-oil Production and Sustainable Energy Resource Recovery Through Optimizing Oxidative Pyrolysis of Banana Waste*”; **Fuels**, 6, pp.1-3.
- Ramachandran S, Joshi A. K., Sojitra M., (2025). “*Cooling Load Prediction of an Off-Grid Solar Under-Ground Cold Storage: A TRNSYS Perspective*”; In: Dwivedi, G., Verma, P., Shende, V. (eds) **Advances in Clean Energy Technologies**. ICET 2023. **Springer Proceedings in Energy**, Springer, Singapore.
- Chandekar B., Rohit M.V., Patel S. K. S., (2024). “*Efficient Dark-Fermentation Biohydrogen Production by Shigella flexneri SPD1 from Biowaste-Derived Sugars through Green Solvents Approach*”; **Bioresource Technology**, 410, 131276.
- Narayanasamy A., Patel S.K.S., Singh N., Rohit M.V., Lee J., (2024). “*Valorization of Algal Biomass to Produce Microbial Polyhydroxyalkanoates: Recent Updates, Challenges, and Perspectives*”; **Polymers**, 16(15), 2227.
- Patel S.K.S., Gupta R. K., Rohit M.V., Lee J., (2024). “*Recent Developments in Hydrogen Production, Storage, and Transportation: Challenges, Opportunities, and Perspectives*”; **Fire**, 7(7), 233.
- Adsul M. G., (2024). “*Cellulolytic Enzymes Recycling Strategies for the Economic Conversion of Lignocellulosic Biomass to Fuels*”; **Process Biochemistry**, 147, 62–74.

Conferences, Invited Talks, Workshops & Meetings

International and National Conferences

- Sojitra M., Joshi A., Dubey M., Mehta J. (2024). “*Preparation and Characterization of Waste Engine Oil-based Nanofluids for Direct Absorption Solar Collector System*”. Research paper presented at the **International Conference on Environmental Science and Technology (ICEST)**, organized by **Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat**, from December 19–21, 2024.
- Anand N., Suthar A., Singh N. (2024). “*Enhanced Bioremediation of Firewood-based Flue Gas Using Microalgae*”. Oral presentation at the **International Conference on Innovations in Biotechnology for Sustainability**, organized by **Jawaharlal Nehru University (JNU), New Delhi**, from November 23–25, 2024.

Invited Talks

- Dr. Anil Kumar Dubey delivered a lecture on “**Biomass Gasification for Hydrogen Production: Future Demands and Trends**” in the ICAR Sponsored 10-Day Short Course on “**Advances in Hydrogen Production for Clean Energy and Environment**” held at ICAR-Central Institute of Agriculture Engineering, Bhopal, on March 24, 2025.
- Dr Rohit Kumar Singh delivered a guest lecture on “**Chromatography for Gas Analysis in Hydrogen Production Processes: Principles and Processes**” in the ICAR Sponsored 10-Day Short Course on “**Advances in Hydrogen Production for Clean Energy and Environment**” held at ICAR-Central Institute of Agriculture Engineering, Bhopal, on March

21, 2025.

- Er Asim Joshi delivered a lecture on **“Renewable Energy (Solar & Biomass) for Sustainable Development”** on the occasion of ‘World Engineering Day for Sustainable Development’, at the Sardar Patel Education Campus affiliated with Sardar Patel University, Vallabh Vidyanagar on March 4, 2025.
- Dr. Anil Kumar Dubey delivered an invited lecture on **“Use of Various Indian Standards on Solid Biofuels”** at the Bureau of Indian Standards (BIS), New Delhi, on February 23, 2025.
- Dr. Anil Kumar Dubey participated in the XVII Agricultural Science Congress and delivered a keynote lecture on **“Valorization of Biomass for Value-Added Products”**, held during February 20–22, 2025.
- Dr Mukul K. Dubey was invited as a panelist in the track, **“Climate Action, Environment & Renewable Energy”** in the Summit of Future, Kerala 2025 at Jain University, Kochi Info Park Campus, Kerala on January 25, 2025.
- Dr. Anil Kumar Dubey participated in the 58th Annual Convention of the Indian Society of Agricultural Engineers (ISAE) at VNMKV, Parbhani, and delivered a lecture on **“Energy Generation from Biomass”**, held during November 12–14, 2024.
- Dr Amrita Doshi was invited as panel expert for the session titled **“Dung to Dollar”** at the **“IWMI-Tata Partners’ Meet 2024”** scheduled during 18–20 September at the National Dairy Development Board (NDDB) campus, Anand, Gujarat.
- Er Bhavin Soni presented the divisional technologies during the **“Investor’s Summit 2024”** organized by PDEU, Gandhinagar, on August 01, 2024.

Workshops

- Dr Rohit K Singh & Er Milan L. Sojitra participated in a 10-day short course on **“Advances in Hydrogen Production in Clean**

Energy and Environment”, sponsored by the Indian Council of Agricultural Research (ICAR), organized by ICAR-Central Institute of Agricultural Engineering, Bhopal, from March 17–26, 2025.

- Dr Rohit Singh and Er Shivam Thakkar attended **“UdyaME Mela”**, an initiative dedicated to promoting non-traditional enterprises in rural areas, held from February 19–21, 2025, at Mukta Kashi Manch, Jhansi, Uttar Pradesh.
- Ms. Drishya P. Kanan participated in a five-day offline workshop titled **“Introduction to Life Cycle Assessment Studies on Bioprocessing and Chemical Engineering – Phase 2”**, organized by CSIR-NIIST, Thiruvananthapuram, from January 6–10, 2025.
- Dr Amrita Doshi attended **“Grameen Bharat Mahotsav 2025”**, held on January 4, 2025, at Convention Center, Bharat Mandapam, New Delhi.
- Dr Anand Narayanasamy participated in the 5-day national hands-on training program on **“Biogas Technology and its Implementation”**, organized by Sardar Swaran Singh National Institute of Bio-Energy, Kapurthala, Punjab, from October 21–25, 2024.
- Dr Amrita Doshi attended **“FPO Farmer Training and Export of Value-Added Horticultural Products from India to Germany”**, organized at Vrindavan Cold Storage, opposite NH-48, Boriavi, by the Department of Horticulture, Jilla Seva Sadan, Anand, on September 25, 2024.
- Dr Anil Kumar Dubey, Dr Mukul Dubey, Dr Amrita Doshi, Er Asim Kumar Joshi & Er Bhavin Soni attended **“RE-INVEST 2024”**, organized by MNRE, New Delhi, at Mahatma Mandir, Gandhinagar, from September 16–18, 2024.
- Er Bhavin Soni participated in a one-day skill training program on **“Introduction to Life Cycle Assessment Studies on Bioprocessing and Chemical Engineering – Phase I”**, organized

by CSIR-NIIST, conducted on June 28, 2024.

- Er Bhavin Soni attended a workshop on **“Advancements in Biochar: Production, Applications, and Market Dynamics”**, organized at IIT Bombay on June 27, 2024.

Meetings

- Dr Mukul K. Dubey attended as an invited participant in the **“Stakeholder Consultation Meeting”** organized by the Department of Science & Technology (DST) in New Delhi on March 28, 2025, to identify key research areas across the Green Hydrogen Value Chain in India.
- Er Asim K. Joshi participated in the **“30th Virtual Meeting of Renewable Energy Sources Sectional Committee, MED 04, Bureau of Indian Standards”**, held on March 19, 2025.
- Er Asim K. Joshi participated in a virtual meeting on February 24, 2025, to discuss issues raised by the Solar Thermal Federation of India (STFI) regarding the **“Quality Control Order on Solar Water Heaters”**, organized by MED 04, Bureau of Indian Standards.
- Er Asim K. Joshi participated in the **“1st Panel Meeting of MED 04, BIS”** on December 2,

2024, to discuss the drafting of the Bureau of Indian Standards for solar dish cookers.

- Er Bhavin Soni visited the **“Banas Bio-CNG Plant”** of Banas Dairy at Dama, Banaskantha, during November 2024 to understand energy mapping and operational challenges.
- Er Bhavin Soni visited **“Sardarkrushinagar Dantiwada Agricultural University, Banaskantha”**, during November 2024 to discuss solar- and biomass-based renewable energy interventions developed by the university’s Renewable Energy Department.
- Er Bhavin Soni visited the **“SARTHI Foundation, Mahisagar”**, during November 2024 to review land and facilities for the proposed installation of a 2-TPD biomass torrefaction and pelletization unit with support from DST-SUNIL.
- Er Bhavin Soni and Dr Rohit K. Singh were invited to visit three industries in the Junagadh and Rajkot districts during October 2024 to explore collaborations for renewable energy interventions in their units.
- Er Asim K. Joshi participated in the **“28th Virtual Meeting of Renewable Energy Sources Sectional Committee, MED 04”**, held on September 25, 2024.

Training/Internships/Dissertation

- **Saifulie Jallow**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Vallabh Vidyanagar, completed a one-month internship on **“Solar Energy Technologies”** in the Solar Energy Division, SPRERI.
- **Mudeet Jain**, B.Sc. student of Environmental Science, XIM, Bhubaneswar, completed a two-month training programme on **“LCA Analysis for the Solar PV Panel”** in the Solar Energy Division, SPRERI.
- **Tasnim Chaviwala**, M.Sc. student of Physics, BITS, Goa, completed a two-month training programme on **“Sustainable Steam Generation using Solar Thermal Energy”** in

the Solar Energy Division, SPRERI.

- **Meet Panchal**, B.Tech. student of Agricultural Engineering, CAET, Dediapada, completed a two-month training programme on **“Nanotechnology Applications in Solar Thermal Systems using Nano PCM”** in the Solar Energy Division, SPRERI.
- **Ankit Kumar**, B.Tech. student of Agricultural Engineering, CAET, Anand, completed a four-month training programme on **“Nanotechnology Applications in Solar Thermal Systems using Nanofluids”** in the Solar Energy Division, SPRERI.
- **Srishti Dalal**, M.Sc. M.Ed. student of Indian

Institute of Teacher Education, Gandhinagar, completed a two-month training programme on ***“Microalgae Based Treatment of Liquid Waste Digestate Generated from Biogas”*** in the Bio-conversion Technology Division, SPRERI.

- **Ankita Yadav**, M.Ed. student of Indian Institute of Teacher Education, Gandhinagar, completed a two-month training programme on ***“Valorization of Biogas Slurry from Organic Fractions of Municipal Solid Waste towards Biofertilizer Applications”*** in the Bio-conversion Technology Division, SPRERI.
- **Suriddhim**, B.Tech. student of Hemwati Nandan Bahuguna Garhwal University, Srinagar, completed a one-month training programme on ***“Methanol Production from Methanotrophic Bacteria through Gas Fermentation Approach”*** in the Bio-conversion Technology Division, SPRERI.
- **Utsab Nandi**, B.Tech. student of BITS Pilani, Pilani, completed a two-month training programme on ***“Biogas Production from Napier Grass”*** in the Bio-conversion Technology Division, SPRERI.
- **Rohit K. Pandey**, B.Tech. student of Hemwati Nandan Bahuguna Garhwal University, Srinagar, completed a one-week training programme on ***“PHA Production Process”*** in the Bio-conversion Technology Division, SPRERI.
- **Aman Kumar**, B.Tech. student of Hemwati Nandan Bahuguna Garhwal University, Srinagar, completed a one-week training programme on ***“Bio-hydrogen Production Process”*** in the Bio-conversion Technology Division, SPRERI.
- **Krina Jayeshbhai Patel**, M.Sc. student of Shri Alpesh N. Patel Post Graduate Institute of Science & Research, Anand, three three-month training programme on ***“Biohydrogen production utilizing various sugars”***, in the Bio-conversion technology division of SPRERI
- **Bilal Aiyubhbhai Momin Suthar**, M.Sc. student of Shri Alpesh N. Patel Post Graduate Institute of Science & Research, Anand, three months training programme on ***“Microalgae cultivation in different media”***, in the Bio-conversion technology division of SPRERI
- **Fenil Markana**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived from Castor and Mustard Oil using CI Engine”*** in the Thermo-chemical Conversion Technology Division, SPRERI.
- **Dhruv Parmar**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived from Castor and Mustard Oil using CI Engine”*** in the Thermo- chemical Conversion Technology Division, SPRERI.
- **Aditya Pandya**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived from Castor and Mustard Oil using CI Engine”*** in the Thermo- chemical Conversion Technology Division, SPRERI.
- **Tirth Songara**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived from Castor and Mustard Oil using CI Engine”*** in the Thermo- chemical Conversion Technology Division, SPRERI.
- **Parth Parmar**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived using Waste Cooking Oil”*** in the Thermo-chemical Conversion Technology Division, SPRERI.
- **Shlok Balodha**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance***

and Emission Testing of Biodiesel Derived using Waste Cooking Oil in the Thermochemical Conversion Technology Division, SPRERI.

- **Vatsal Modi**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived using Waste Cooking Oil”*** in the Thermo-

chemical Conversion Technology Division, SPRERI.

- **Kaushik Soni**, B.Tech. student of Mechanical Engineering, BVM Engineering College, Anand, completed an internship on ***“Performance and Emission Testing of Biodiesel Derived using Waste Cooking Oil”*** in the Thermochemical Conversion Technology Division, SPRERI.

Visitors

- M/s. Stuti Industries, Anand visited the institute during March 2025 to understand the biomass densification process for the installation of a production unit at their premises
- A team from Encoat Industries Pvt Ltd, Pune, visited the institute during February 2025 to understand about the Efficient Improved Biomass Cookstoves developed by the institute
- A team from Surya Industries, Sangli, visited the institute during January 2025 to understand the Efficient Improved Biomass Cookstoves developed by the institute
- A team from TAP-Rise, New Delhi visited the institute during December 2024 to understand about the SPRERITECH Improved Biomass Cookstove and registered an MNRE approved model (NDSL-190) on their online portal
- A team from Quality Agro Fuel, Jetpur, visited the institute during November 2024 to review the biomass torrefaction system and collaborative work for the development of an industrial-scale biomass torrefaction system
- Mr Kailesh M. Patel, Executive Engineer at DGVCL, Surat, visited the institute during October 2024 to explore the potential of PM-KUSUM yojna installation in Gujarat state.
- Dr Pindoriya, Associate Professor from AERC, visited the institute during October 2024 to finalize the details of the interventions under

DST SUNIL programme.

- Mr. Arshad Rana, General Manager at Christian Pfeiffer Pvt. Ltd., visited the institute during September 2024 for Gasification technology transfer.
- A team from the ISKCON Temple, Ahmedabad, visited the institute during September 2024 to review the Green Steam Generation using Biomass for their kitchen facilities
- The project team of Amul, Anand, visited the institute during August 2024 to review the biochar-based bulk milk chiller effluent treatment system
- Dr G. V. Shankar and Dr Sudarshan Suryawanshi from Axiomex Group, Canada, visited the institute during July 2024 to discuss the potential for joint work under Kerla Hydrogen Valley Innovation Cluster.
- A team from Varhad Group, Pune, visited the institute during July 2024 to review the pyrolysis facilities and the development of a suitable burner pyro-gas combustion
- Sankhya Earth visited the institute during June, 2024 to discuss the way ahead for biochar production and its utilization in fertilizer industries
- A team from the Sahjeevan Group, Bhuj, Kutch, visited the institute during May 2024 to review the technologies for biochar production using Prosopis Juliflora

The Team

Director

Dr Anil Kumar Dubey

Solar Energy Division

- Dr Mukul Kumar Dubey, Principal Scientist and Head
- Er Asim Kumar Joshi, Senior Scientist
- Er Milan Sojitra, Associate Scientist
- Mr Mahendra Padhiyar, Jr. Lab Assistant
- Mr Mukesh Jadav, Helper
- Dr Ravi Kant, Associate Scientist (till 24/10/2024)

Bio-conversion Technology Division

- Dr Mukund Adsul, Principal Scientist and Head
- Dr Neha Singh, Senior Scientist
- Dr Maku V. Rohith, Senior Scientist
- Dr Anand Narayanasamy, Research Associate
- Mrs Aesha Patel, Senior Research Fellow
- Ms Drishya P K, Senior Research Fellow
- Ms Mareena Jose, Junior Research Fellow
- Ms Aditi Suthar, Project Associate
- Mr Ashok Harijan, Lab Attendant
- Mr Ashok Mochi, Helper
- Mr Harman Parmar, Helper
- Mrs Manjula Vadhel, Helper
- Ms Bilwa Chandekar, Junior Research Fellow (till 31/05/2024)

Thermo-chemical Conversions Technology Division

- Dr Geeta Kumari, Principal Scientist & Head
- Dr Rohit Kumar Singh, Senior Scientist
- Er Bhavin Soni, Associate Scientist
- Er Aanand Lakhani, Senior Research Fellow
- Er Akanksha Pawar, Junior Research Fellow
- Er Shivam Makawana, Project Associate
- Mr Ashok Patel, Helper
- Er Urvish Patel, Senior Research Fellow (till 18/05/2024)

Technology Transfer & Extension Division

- Dr Amrita Doshi, Senior Scientist & In-charge
- Dr Pranay Lanjekar, Program Officer
- Er Shradhdha Pandya, Senior Research Fellow
- Er Ravindrasinh Gohil, Program Professional
- Er Shivam Thakar, Project Associate
- Mr Minesh Suthar, Jr. Technician
- Mr Shailesh Solanki, Helper
- Dr Krishna Solanke (till 29/01/2025)

Administration & Finance Division

- Mr Bipin K Patel, Account & Admin Officer
- Mr Hashmukh Vaghela, Jr. Office Assistant
- Mr Mayur Parmar, PA to Director
- Mr Chetan Parmar, Sr. Account Assistant
- Mr Bhupendra Prajapati, Electrician
- Mr Dahya Harijan, Jr. Mechanic
- Mr Rajesh Machi, Driver
- Mr Bhupendra Parmar, Helper

Balance Sheet

B. C. PATEL & CO.
Chartered Accountants

1 Desai Building
Maifer Road, Anand - 38001
Ph. No. (02692) 244893

SARDAR PATEL RENEWABLE ENERGY RESEARCH INSTITUTE - VALLABH VIDYANAGAR
BALANCE SHEET AS ON - 31 - 03 - 2025

FUNDS & LIABILITIES	31/03/2024	31/3/2025	ASSETS	31/03/2024	31/3/2025
CAPITAL FUND	10 82 669.20	10 82 669.20	FIXED ASSETS		
PROJECT FUND			1. Furniture & Fixtures	2 49 808.62	2 49 808.62
Balance from last year	1 03 27 209.67	1 50 90 846.67	2. Electric Fittings	1 62 350.85	1 62 350.85
Add / Less during the year	47 63 637.00	34 09 315.00	3. Mobile Phone	19 600.00	19 600.00
(As per Schedule - 4)	1 50 90 846.67	1 85 00 161.67	4. Institute Equip.(R & D / Others)	10 71 372.00	10 71 372.00
PROJECT EQUIPMENT			5. Car - GJ-23 AF-0282	5 85 597.00	5 85 597.00
Depreciated value of Equipment	12 93 42 359.51	13 03 02 244.51	6. New Jeep - GJ-23-GA-0488	8 34 000.00	8 34 000.00
Add : During the year	9 59 885.00	36 11 370.00		29 22 728.47	29 22 728.47
(As per Schedule - 1)	13 03 02 244.51	13 39 13 614.51	PROJECT EQUIPMENT	13 03 02 244.51	13 39 13 614.51
Gratuity Fund	66 91 819.19	65 14 125.57	INVESTMENT		
EAR MARKED FUND			Fixed Deposit (As per Schedule -2)	3 25 61 935.00	3 87 99 712.00
1. Building Fund Provision	35 32 595.00	35 32 595.00	Deposit in LIC - Graduity Scheme	66 91 819.19	65 14 125.57
2. Research & Development Fund	1 04 60 434.83	1 04 60 434.83		3 92 53 754.19	4 53 13 837.57
3. Contingent Development Fund	1 40 070.00	1 40 070.00	LOANS & ADVANCES		
4. Depreciation Fund	69 88 937.30	70 77 841.30	1. Tax Deduction at Source	6 89 484.06	2 90 894.00
5. Endowment Fund (Hari Om Ashram)	15 14 118.75	15 14 118.75	2. Telephone Deposit	20 313.00	20 313.00
6. Share & Care Fund	1 60 477.00	1 60 477.00	3. CGM Deposit(Oil Diesel & Petrol)	12 400.00	42 400.00
7. Maint. Fund (Core Grant)	7 62 173.00	7 62 173.00	4. Indian Oxyzen Ltd., Deposit	4 252.94	4 252.94
8. Depreciation Investment Fund	4 78 006.00	4 78 006.00	5. Mobile Phone Deposit	4 680.00	4 680.00
9. Staff Welfare Fund	17 82 628.95	17 44 896.95	6. Broad Band Security Deposit	3 000.00	3 000.00
10. Quiz Prog. Fund	61 175.00	61 175.00	7. Gas Cylinder Deposit	10 350.00	10 350.00
11. Donation (Gen.)	23 18 674.00	25 03 454.00	8. Security Deposit(GEB - New DP)	1 00 920.00	1 00 920.00
(As per Schedule - 5)	2 81 99 289.83	2 84 35 241.83	9. Loan to Staff & Advance to Project	8 34 642.00	9 43 466.00
			10. Intrest Accrued	19 13 980.00	41 15 847.00
				35 94 022.00	55 36 122.94
Balance as per last Balance Sheet			BALANCE :		
Balance as per last Balance Sheet	14 206.80	19 97 924.33	Bank Balance (As per Schedule - 3)	72 34 009.56	56 21 965.35
Add/ Less : - As per Inc & Exp. A/c	19 83 717.53	28 81 572.73	Cash Balance	58 035.00	17 041.00
Add:- Surplus	19 97 924.33	48 79 497.06		72 92 044.56	56 39 006.35
TOTAL	18 33 64 793.73	19 33 25 309.84	TOTAL	18 33 64 793.73	19 33 25 309.84

Date :- 17/09/2025
Place :- Vallabh Vidyannagar


Accounts Officer




Director




B. C. PATEL & CO.
Chartered Accountants
Mem. No. 32231

Acronyms & Abbreviations

AICRP	All India Coordinated Research Project	ILs	Ionic Liquids
AP	Acidification Potential	ISO	International Organization for Standardization
BEE	Bureau of Energy Efficiency	ITI	Industrial Training Institute
CCUS	Carbon Capture Utilization and Sequestration	JTDS	Jharkhand Tribal Development Society
CFC	Chlorofluorocarbon	LCA	Life Cycle Assessment
CNC	Cellulose Nanocrystals	LCIA	Life Cycle Impact Assessment
COP	Coefficient of Performance	LNP	Lignin Nanoparticles
CSR	Carbon-to-Steam Ratio	LPG	Liquefied Petroleum Gas
DBT	Department of Biotechnology	MCC	Microcrystalline Cellulose
DCB	Dichlorobenzene	MNRE	Ministry of New and Renewable Energy
DST	Department of Science and Technology	MoU	Memorandum of Understanding
EDX	Energy Dispersive X-ray Spectroscopy	MSD	Micro Solar Dome
EP	Eutrophication Potential	MT	Metric Tonne
EPD	Department of Energy and Petrochemicals	NADES	Natural Deep Eutectic Solvent
ETP	Ecotoxicity Potential	NP	Nanoparticle
FES	Foundation for Ecological Security	PCM	Phase Change Material
FTIR	Fourier Transform Infra-Red Spectroscopy	PNG	Piped Natural Gas
FWEO	Filtrate of Waste Engine Oil	PUFA	Polyunsaturated Fatty Acid
GAA	Glacial Acetic Acid	PV	Photovoltaic
GEDA	Gujarat Energy Development Agency	PVA	Polyvinyl Alcohol
GHI	Global Horizontal Irradiance	PVT	Photovoltaic-Thermal
GSBTM	Gujarat State Biotechnology Mission	RE	Renewable Energy
GUJ-COST	Gujarat Council of Science and Technology	RPM	Rotations Per Minute
GWP	Global Warming Potential	RSM	Response Surface Methodology
HBA	Hydrogen Bond Acceptor	SC	Scheduled Caste
HBD	Hydrogen Bond Donor	SCSP	Scheduled Caste Sub Plan
HHFAD	Hybrid Horizontal Flow Anaerobic Digester	SDG	Sustainable Development Goals
HTP	Human Toxicity Potential	SEM	Scanning Electron Microscope
ICAR	Indian Council of Agricultural Research	SHG	Self-Help Group
		SS	Stainless Steel
		TEM	Transmission Electron Microscope
		TRNSYS	Transient System Simulation Tool
		WSGR	Water Gas Shift Reaction

- Portable double-glazed solar dryer
- Thermal energy storage based Indirect solar dryer
- Standalone type PV integrated solar low tunnel dryer
- Forced circulation solar cabinet dryer
- Solar-biogas hybrid cold storage system
- Solar refrigerator with thermal back-up
- Solar PV driven micro cold storage with thermal energy storage
- Solar evacuated tube with heat pipe-based desalination system
- Solar evacuated tube with heat pipe collector-based pressure-cooking system
- Thermal energy storage integrated solar concentrating dish-based cooking system
- Thermal energy storage integrated solar Fresnel lens-based cooking system
- Solar photovoltaic-thermal (PVT) hybrid collector for air heating
- Nano integrated heat transfer fluid for efficient solar heating applications
- Solar-based wax melting system
- Sun tracker (single axis) for photovoltaic panels
- Bio-methanation technology for Mandi and kitchen waste
- Micro crystalline cellulose production from agro-residues
- Bio-composting technology from agro-residue
- Biogas technology for agro-industrial effluent
- Bio-methanation technology for dairy effluent and scum
- Continuous biochar production system
- Fast pyrolysis system for bio-oil production
- Biochar cum activated bio-carbon production system
- Bulk milk chiller effluent treatment unit
- Fluidized bed gasifier for agro-residues
- Down draft biomass gasifier system for power and thermal applications
- Biomass combustor for hot air and steam generation
- Biomass cookstoves for domestic and commercial applications
- Multi blade wood cutter for feedstock preparation for gasifier

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