2022

IMPLEMENTATION OF SDG-7: AFFORDABLE AND CLEAN ENERGY IN SHOOLINI UNIVERSITY, HIMACHAL PRADESH, INDIA

STATUS REPORT 2022

Centre of Excellence in Energy Science and Technology
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Report on Implementation of SDG-7: Affordable and Clean Energy in the Shoolini University, Himachal Pradesh, India

Executive Summary

As per THE Impact Ranking 2023, Shoolini University has bagged top no.43 global ranking for SDG 7 and No.41 in SDG 6. The Centre of Excellence in Energy Science and Technology (CEEST) is coordinating the implementation of United Nations Sustainable Development Goals (UNSDGs) in Shoolini University. In order to ensure the access to affordable, reliable, clean, and sustainable energy for all, the University has taken several measures and formulated and implemented the Energy and Environment Policies in order to achieve the UNSDG targets. Shoolini University has published a National Document on the Implementation of United Nations Sustainable Development Goals (UNSDGs) in Higher Education Institutions in collaboration with Association of Indian Universities (AIU). Under this initiative a number of steps in awareness, education, research and transfer of technology have been taken to utilize renewable energy sources to conserve energy, reduce carbon emissions and combat climate change impact by 2025. The use of solar energy for power generation, reduction in the use of fossil fuels in transportation, community cooking, building design and construction have been taken. This report presents the status of implementation of UNSDG SDG-7 and governing policy at Shoolini University, Solan, Himachal Pradesh, India during 2022-23.

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1. Introduction

The Centre of Excellence in Energy Science and Technology (CEEST) is coordinating the implementation of United Nations Sustainable Development Goals (UNSDGs) in the Shoolini University. In order to ensure the access to affordable, reliable, clean, and sustainable energy for all. Shoolini University has taken several measures in renewable energy education research, technology implementation and formulated and implemented the Energy & Environment Policies in order to achieve the UNSDG -7 targets. The university intends to develop itself as a sustainable energy education and research hub and a sustainable development township to act as a model for other Higher Education Institutions in India.

The University has implemented several environmentally friendly solar projects in the University campus for generating solar electricity, hot water and solar steam cooking and energy efficient net zero energy buildings. Under the projects from Ministry of New & Renewable Energy, Govt of India, the Campus of Shoolini University has been converted into a Green Energy Campus with solar energy utilization & environmentally friendly technologies.

1.1 Education

The global thrust on utilization of Renewable Energy utilization to reduce greenhouse gas emissions for climate change mitigation calls for all organizations and higher education institutions to take immediate measures to lower their carbon footprint. Shoolini University has established a Shoolini University has established a Centre of Excellence in Energy Science & Technology (CEEST) in 2019 which is led by Prof. Shyam Singh Chandel who comes under the global top 2% scientists according to research conducted by Stanford University.
(Stanford Research Link: https://elsevier.digitalcommonsdata.com/datasets/btchxktzyw)

CEEST has introduced education at B.Tech (Renewable Energy Technology), Master in Energy Technology. Master in Climate Science and Sustainable Development and PhD in Energy, Renewable Energy and Climate Change concerns and, Sustainable development. CEEST was ranked 3rd in India for Environmental Science and 15th in India for Energy Research by SCIMAGO Institutes Rankings 2022. The Centre's Scientists have a large number of publications in quality research journals. A large number of patents have already been filed through the same.

CEEST Website link: https://shooliniuniversity.com/center-of-excellence-in-energy-science-and-technology.

SCIMAGO Ranking Link:

Rank-3:

https://www.scimagoir.com/rankings.php?sector=Higher+educ.&area=2300&ranking=Overall&country=IND

Rank-15:

https://www.scimagoir.com/rankings.php?sector=Higher+educ.&area=2100&ranking=Overall&country=IND

1.2 Research in Energy and Climate Action

A large number of research papers in these areas have been published in top ranking Journals which has led to rank 2 for SDG 7 & No.6 in SDG 6 for the University as per THE global impact ranking in 2022 and rank 43 and 41 respectively in 2023.

Evidence:

SDG-7 Rank (2023): https://www.timeshighereducation.com/rankings/impact/2023/affordable-and-clean-energy?page=1

SDG-6 Rank (2023): https://www.timeshighereducation.com/rankings/impact/2023/clean-water-and-sanitation?page=1

Research in Energy to SDG-7 and 13 of Shoolini University:

(Annexure I- List of Publications Related to Energy)

Highlighted research of Centre of Excellence in Energy Science and Technology in 2023

Article in PV Magazine: CEEST is researching into new alternative energy technologies to lower carbon footprint hence contributing to SDG-7 fulfillment:
https://www.pv-magazine.com/2022/11/04/pv-powered-thermoelectric-cooling-for-air-conditioning-in-buildings/

CEEST has catalyzed the action on sustainable Development goals in the University by preparing a National Document titled as "**Building a Sustainable Future - How Universities Can Help Implement SDG Goals"** on the Implementation of UN SDGs in Higher Education Institutions in India in collaboration with Association of Indian Universities (AIU) during 2021 which has been published in March, 2023 and launched by the **former President of India** Mr. Ramnath Kovind.

Evidence: https://shooliniuniversity.com/news/former-president-kovind-releases-shoolini-aiu-joint-publication

Already a governing 'Energy and Environment Policy' has been formulated in 2019 to set the roadmap and required actions to make the University carbon neutral by 2025.
In addition to the latter, the CEEST has also prepared two new policies namely the sustainable procurement and sustainable investment policies of the university to further align the university towards the SDGs. The scientists are working in priority research areas on Climate change in Energy, especially use of renewable energy applications in Agriculture, Sciences, Engineering, Biotechnology, Food technology and Pharmacy. The main objective of these initiatives is to develop the University as a sustainable education and research hub and township to be model for the higher education Institutions in India.

1.3 Energy Patents
Refer to Annexure-II for energy patents granted in 2022.

2. Initiative on Solar Photovoltaic power generation -Installation of a 400 kWp Grid Connected Solar Photovoltaic Power Plant - An initiative under United Nations Goal 7 and 13

Solar Energy is harnessed through Solar Photovoltaic panels installed on the rooftops of the University building blocks, hostels and car parking. The University campus is connected to the main grid operated by HP State Electricity Board (HPSEB). The solar electricity so generated is used to meet the partial energy needs of the University. The electrical energy used by the university was 6,422 GJ and that generated by solar PV plant was 1476.4 GJ offsetting about 3,34,237 kgs of CO_2 in 2022.

Figure 1: 400 kWp Grid connected Solar Photovoltaic Power Plant at Shoolini University

Figure 2: Distribution of 400kWp grid-connected Solar Photovoltaic Power Plant on different rooftops and Car parking shed in the university campus

3. Concentrated Solar Steam Generating Cooking System

A solar steam generating cooking system (Scheffler Type) is installed on the roof top of Girls hostel of Shoolini University. The system is based on the concentrated solar technology.

Figure 3: Concentrated solar powered community steam cooking system

The solar radiation falling on the dish, is concentrated onto a receiver, which heats the water and convert into steam to cook food for 500 girl students residing in the hostel saving about 2 LPG gas cylinders every day thus saving conventional fuel and money. The system is also used as a research facility by the PhD student to design and monitor the performance of the CSP system.

Figure 4: Concentrated solar steam cooking system installed on roof top of the girls hostel at Shoolini University

4. Solar water heating systems for hostels

Solar flat plate collector and evacuated tube collectors are installed in all hostels of the University provide hot water daily for hostel residents.

Figure 5: Installation of 38000 litres per day solar water heating systems in the university campus.

5. Reducing fossil fuel consumption and carbon dioxide emissions use of electric carts for local transportation in the campus

The university has introduced three electric carts for local transportation for students, faculty and visitors inside the university campus to restrict the movement of personal vehicles inside the campus during working hours.

Figure 6: Electric Carts for local transportation in the university campus.

6. Bio-energy utilization - Use of biogas for Cooking from agriculture and Animal Wastes

In order to utilize agriculture, cow dung, food waste and kitchen waste, and promote the research and use of biogas as the fuel, the CEEST has installed a 1.5 m^3 Plastic biogas system for demonstrating use of non-polluting fuel in the agricultural farm of the University which is being used for cooking by the farm laborers.

Figure 7: Biogas plant for cooking installed in agriculture farm in Shoolini university

7. Installation of Solar Street Lights and Smart Sensor Lights

Shoolini University has installed about 42 solar street lights of 40W capacity inside the campus for night time lighting purposes thus utilizing free Solar energy and saving conventional electricity. A number of smart sensor lights have also been installed that automatically turn off when not in use to save electricity.

Figure 8: Sensor based lights at various restrooms have been installed. These sensors detect the presence of a person and turn off when there is no human presence in the rooms.

Figure 9: Solar streetlights installed in the University campus.

8. Monitoring solar, wind, and other climate data for research

CEEST has installed a high quality automatic weather station on the roof top of the library building that monitors Global Solar Irradiance, Wind Speed, Wind Direction, Temperature, Relative Humidity, Rain fall data as well as photosynthetic active radiation which are critical for

research and development of new Energy technologies, Climate Change related hence contributing towards research and development SDG-7 and SDG-13. The data are being used in boosting the reliable research and development of renewable energy technologies, by utilization of the renewable resources, and making plans for the sustainable township.

Figure 10: CEEST Automatic Weather Station installed at Shoolini University. The weather station is equipped to monitor solar radiation, temperature, humidity, photosynthetic active radiation as well as wind speed and direction.

9. Participation in National and International Conferences Related to Energy

Teachers, researchers, and students have participated in international and national conferences related in the field of renewable resources, storage systems, smart grids, hybrid systems, etc.

10.Establishment of New Solar Energy Research Labs

High tech labs in Photovoltaic, Solar thermal, Wind and Bioenergy are being planned to be established in a phased manner for education, research based on the state-of-the-art technologies that help researchers and students and participate in utilizing and improving the existing technologies and developing new ones.

11.Energy Conservation & Energy Efficiency improvement

Sensors are used for energy conservation in the University. 90% of lights in the university are LED based 20-Watt tube light which saves up to 50% energy. Most streetlights in the campus have photocell controllers, which switch the light on and off at the right natural light levels, normally near dusk and dawn. These sensors have time delays and hysteresis to prevent change-over too quickly. There is a plan to convert to 100% sensor-based street lighting/ outdoor lighting system to prevent wastage of electricity.

Use of LED Lighting: University campus is moving towards total LED lighting system, which are more efficient than incandescent light bulbs or compact fluorescent lighting (CFL). The campus has 90% , 20 W LED lights.

Figure 11: 20W LED lights installed in the University

Use of more efficient water and air heating systems: The university has installed 8kW heat pump based water heating system in the international hostel and PTC air heaters to optimize and improve energy efficiency.

Figure 12: Energy efficient heat-pump based water heating system has been installed in the international hostel Shoolini University

Figure 13: Energy efficient PTC air heaters have been installed all international hostel rooms

Use of energy efficient architectural features: The university has incorporate various feature in the new buildings like use of natural lighting and solar energy, use of Autoclaved Aerated Concrete (AAC) blocks, 'Rat Trap' Builds i.e. cavity induced in wall which provides the advantage of thermal comfort.

Figure 14: Use of large windows for increased solar gain and increased use of natural lighting.

Figure 15: Walls using AAC blocks for better insulation and energy efficiency

Figure 16: Walls with Rat traps for better insulation and thermal comfort

12. Energy Policy of Shoolini University

Shoolini University is committed to United Nations Sustainable Development Goals through its innovative energy policy to make Shoolini University a sustainable, energy efficient green campus. This energy policy applies to all operations and activities of the University including building construction, renovation, transportation, and any other operations for improving energy efficiency through the installation of energy efficient systems and use of renewable energy sources. The environment protection, efficient water management and fossil fuel use reduction in various activities undertaken by the University are the linked aspects of this policy. The various measures are to be undertaken for the divestment of energy consuming, and fossil fuel based existing equipment/vehicles etc., with innovative energy efficient systems and to invest in Climate Change solutions for a Carbon Neutral University Campus by 2025 ***(For details refer to Energy Policy Shoolini University provided separately along with this document).***

12.1. Policy Goals

- To take measures to reduce greenhouse gas emissions to make Shoolini University as Net Zero or near Zero building Carbon neutral Campus preferably by 2025.
- To design and construct all the new buildings by incorporating energy efficient, solar passive building, water conserving and environment friendly building technologies.
- To discourage the fossil fuel-based power generation by utilizing renewable energy sources, solar roof-top PV /hybrid systems, waste to energy generation, to meet the energy requirements of the University.
- Measures will be taken to use solar water heating systems, solar steam cooking systems, in university hostels to save LPG and other conventional fuels.
- To take necessary steps to regulate public transportation inside the campus and, and to utilize electric vehicles inside the campus for essential transportation.

12.2 Initiatives already taken under the Solar Energy Policy – Summary

Energy Conservation: Energy conservation is major concern for planning the construction of buildings in a sustainable campus. Nestled in the green and salubrious clime of pine forests, the buildings have been constructed allowing maximum light, ventilation with natural air circulation in all rooms and halls, thereby saving on electricity consumption. There is a major endeavor at Shoolini University to conserve energy and promote the usage of alternate energy sources. Actions taken in this direction have helped in making the campus green, energy efficient and energy surplus. Apart from the measures described below, there are buildings like the Yogananda Knowledge Center (Central Library) that use the natural light during the day.

The faculty, employees and students lead initiatives also save significant electricity and have developed a policy for reducing electricity consumption by using LED and replacing the old florescent tube lights with energy efficient LEDs. All the computer monitors have been replaced with LED/LCDs displays. Replacement of old energy consuming appliances like lights, fans with energy-efficient appliances is underway.

- **Green Energy Campus:** Under the Ministry of New & Renewable Energy, Govt of India, the Campus of Shoolini University is a green energy Campus with maximum Solar Energy utilization & environmentally friendly technology use. The establishment of Centre of Excellence in Energy Science & Technology in 2019 focusses on energy Education and Research.
- **Solar Energy** is harnessed through Solar Photo Voltaic panels installed on the rooftops of most of the University building blocks and covered common areas exposed to sunlight, like the car park, part of the internal road etc., converting sunlight into electric energy. The University campus is connected to the State electricity grid through a grid interactive system. The generated electricity partially meets the requirements of the university and excess generated electricity is transferred to the grid sub-station.
- **Solar Steam Generating Cooking Systems (Scheffler Type) in Girls Hostel of Shoolini University**: A solar steam generating system based on Concentrated Solar Technology Solar radiation falling onto the dish is concentrated onto the receiver, which heats the water which is converted into steam to cook food for 500 students.
- **Solar Water Heating Systems for hostels:** Flat Plate Collector and evacuated Tube collectors are installed in all hostels of the University to provide hot water.
- **Sensor-Based energy Conservation** is being practiced. Most streetlights in the campus have photocell controllers, which switch the light on and off at the right natural light level, normally near dusk and dawn. They have time delays and hysteresis to prevent change-over too quickly. There is a plan to convert to 100% sensor-based street lighting/ outdoor lighting system to prevent wastage of electricity.
- **Use of LED Lighting:** University campus is using LED lighting system, far more efficient than incandescent light bulbs or compact fluorescent lighting (CFL).

13. Solar Passive building technology Policy Initiative-towards Net Zero and Zero Carbon Emission Buildings

Shoolini University has made it mandatory to design and construct all the buildings in its campus as per passive solar architecture and incorporating energy efficient building technologies and environment friendly building materials following the Solar House Action Plan & Policy adopted in the State of Himachal Pradesh.

- The feasibility of existing buildings for retrofitting of Passive Solar features/systems for improving energy efficiency and reducing energy consumption will be explored for urgent follow up action.

Co-ordination & Implementation Guidelines

i. The Centre of Excellence in Energy Science & Technology (CEEST), established in 2019 at the Shoolini University coordinates the Solar Building Action Plan for Shoolini University.

ii. A technical Project Management Cell (TPMC) has been established in the CEEST with Director (Energy) as the Principal Coordinator along with expert team in solar building design, renewable technology analysis, Director (Estate) & building maintenance in charge with concerned architect, civil/electrical engineer team for the construction implementation and maintenance.

iii. A Computer Aided Solar Passive Design Cell with architect, design engineer [structural], executive engineer, a computer programmer well versed in building design software, AutoCAD, seismic analysis software, along with Solar radiation data & building performance monitoring, forecasting load analysis using Artificial Intelligence techniques will be established.

iv. The constructed buildings will be live laboratories for energy education, research and development for CEEST.

v. Systematic efforts will be made by CEEST to orient & train University's technical. Architecture and engineering sections for adopting the innovative technologies.

vi. The CEEST will also promote the technology around nearby villages to help design their houses as social obligation to the communities along with providing technology inputs for the State of Himachal Pradesh Housing Agencies for effective implementation & Policy formulation.

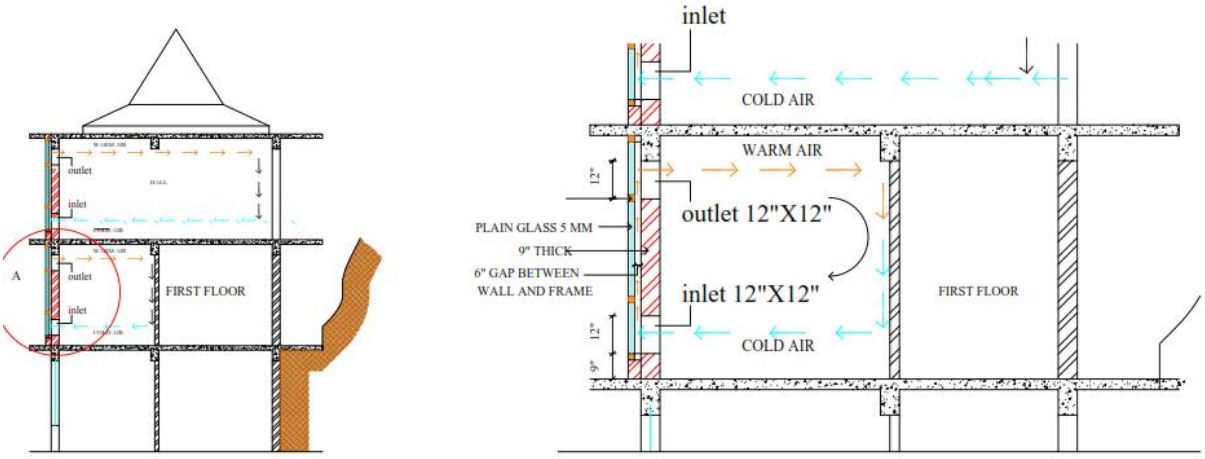

Figure 17: Solar Trombe Wall design which is being constructed in one of the new buildings at Shoolini University.

Figure 18: Animal House building at Shoolini university being built with integrated Trombe Wall for better energy efficiency and thermal comfort

13.1 Constructing low carbon footprint buildings -use of environment friendly building materials

Under the mandatory Net Zero Energy and Passive Solar housing Policy, the university has developed a Yoga Nanda Ville with a number of solar huts in the campus using sustainable building materials like wood, bamboo, slate, stone, mud, stabilized mud blocks etc. shown in figures 22 to 28. Several new buildings including Tagore School of Design Building has been constructed using sustainable materials and minimal carbon footprint figure-19,20,21.

Figure 19: New Design School Building constructed using sustainable materials at Shoolini University.

Figure 20: Interiors of the green buildings at Shoolini University are also made of natural and sustainable materials for maximizing eco friendliness. Ample windows are constructed for natural daylighting and minimal use of artificial lighting during the day. All lights used are energy efficient LED lights.

Figure 21: Side view of School of Design Sustainable Building.

Figure 22: Bamboo and slate Roof E-Studio for online lectures constructed during COVID times

Figure 23: Living with Nature - Eco friendly Bamboo Tree Houses built at various locations in the campus for student interaction

Figure 24: Use of traditional and climate responsive building materials -two storeyed guest house.

Figure 25: Sustainable buildings in Yogananda Ville at Shoolini University.

Figure 26: Sustainable building in Yogananda Ville at Shoolini University.

Figure 27: Sustainable huts and green spaces are constructed at numerous locations within the university

Figure 28: Interior of one of the sustainable residential guest huts

14. Environment Policy for Shoolini University

Shoolini University is committed to United Nations Sustainable Development Goals (SDGs) through its innovative Environment Policy which makes Shoolini University a sustainable, energy efficient and environment friendly green campus. This Environment Policy applies to all the operation and activities of the University including building construction and renovation, transportation, water, waste management and all its operations and activities undertaken by the university***. (Annexure-III- Environment Policy Shoolini University).***

14.1 Policy Goals

- To protect environment in and around Shoolini University
- To develop a systematic waste management mechanism
- To develop rainwater harvesting system for water conservation and recharging
- To provide training and information on energy & environment protection measures
- To create awareness among students, faculty, employees and public to engage in initiatives those contribute for environment protection
- To reduce, reuse and plastic in any manner inside the University campus
- To create awareness on single use plastics impact on environment and encourage use of natural alternatives
- To explore production of energy from waste

- To take measures for the effective utilization of wastewater recycling
- To take measures to protect the forest and environment from forest fires

15. SDG 7 related Society Awareness Campaigns & Webinars organized on Evidence

15.1 Awareness Campaign on National Energy Conservation Day

Shoolini University observed the National Energy Conservation Day and initiated an awareness campaign on energy efficiency and sustainable practices from Dec 14, 2022 to Dec 20, 2022.

Evidence: https://himachaltonite.com/himachal/national-energy-conservation-day-observed-at-shoolini-university/

15.2 Awareness Campaign on 17 SDGs w.e.f International Earth Day

A Campaign was organized by CEEST on 17 SDGs in collaboration with the IT department and Dean Student Welfare for students and faculty of Shoolini University, held starting from the Earth Day on Apr-22, 2022 onwards for 17 days daily. The campaign aimed to spread awareness among the students, faculty and staff about the 17 United Nations Sustainable Development Goals. Posters were published daily on the mobile phones daily for all students/faculty and staff talking about the SDGs.

Evidence: https://himachaltonite.com/himachal/shoolini-university-celebrates-world-earth-day/

16. Support for new technology development and entrepreneurs

CEEST, Shoolini University also hosts Technology Incubation Centre of Ministry of Micro, Small and Medium Enterprises (MSME) and supports innovative ideas from students, entrepreneurs and startups in the state of Himachal Pradesh and encourages use of new sustainable technologies to contribute towards SDGs. The Centre reviewed proposals for Hackathon 2.0 and 3.0 which is a govt. sponsored call for entrepreneurial proposals to be funded by the MSME in 2022 and 2023.

Annexure I- List of Publications Related to Energy (SDG-7)

S. No.	Title	Authors	Year	Scopus Source title
1	Prospects of sustainable photovoltaic powered thermoelectric cooling in zero energy buildings: A review	Rahul Chandel | Shyam Singh Chandel | Deo Prasad | Ram Prakash Dwivedi	2022	International Journal of Energy Research
2	Review on thermoelectric systems for enhancing photovoltaic power generation	Rahul Chandel | Shyam Singh Chandel | Deo Prasad | Ram Prakash Dwivedi	2022	Sustainable Energy Technologies and Assessments
3	Research outcome of sustainable solar drying technology dissemination for preserving perishable agriculture and horticulture crops in the North Western Himalayan region of India	R.K. Aggarwal | Shyam Singh Chandel | Shiva Gorjian | Rahul Chandel	2022	Sustainable Energy Technologies and Assessments
4	Perspective of new distributed grid connected roof top solar photovoltaic power generation policy interventions in India	Rahul Chandel | Shyam Singh Chandel | Prashant Malik	2022	Energy Policy
5	A Novel Metaheuristic Approach for Solar Photovoltaic Parameter Extraction Using Manufacturer Data	Salwan Tajjour | Shyam Singh Chandel | Hasmat Malik, Majed A. Alotaibi | Taha Selim Ustun	2022	Photonics
6	Utilization of biodegradable novel insulating materials for developing indigenous solar water heater for hill climates	S Kaur | RJ Konwar | P Negi, S Dhar | K Singh | SS Chandel	2022	Energy for Sustainable Development
7	An experimental analysis of enhancing efficiency of photovoltaic modules using straight and zigzag fins	M Firoozzadeh | AH Shiravi | SS Chandel	2022	Journal of Thermal Analysis and Calorimetry
8	A Comprehensive Review on Four decades of Thermally Efficient Biomass Cookstove Initiatives for Sustainable Development in India	R K Aggarwal and SS Chandel	2022	International Journal of Ambient Energy
9	Impacts of environmental regulations on green economic growth in China: New guidelines regarding renewable energy and energy efficiency	Zhao, X.| Mahendru, M.| Ma, X.| Rao, A.| Shang, Y.	2022	Renewable Energy

10	Properties, optimized morphologies, and advanced strategies for photocatalytic applications of WO3 based photocatalysts	Shandilya, P.| Sambyal, S.| Sharma, R.| Mandyal, P.| Fang, B.	2022	Journal of Hazardous Materials
11	The role of renewable energy and natural resources for sustainable agriculture in ASEAN countries: Do carbon emissions and deforestation affect agriculture productivity?	Chopra, R.| Magazzino, C.| Shah, M.I.| Sharma, G.D.| Rao, A.| Shahzad, U.	2022	Resources Policy
12	Simultaneous Dual-Functional Photocatalysis by g-C3N4-Based Nanostructures	Akhundi, A.| Zaker Moshfegh, A.| Habibi-Yangjeh, A.| Sillanpää, M.	2022	ACS ES and T Engineering
13	Artificial leaf for light-driven CO2 reduction: Basic concepts, advanced structures and selective solar-to-chemical products	Kumar, A.| Hasija, V.| Sudhaik, A.| Raizada, P.| Van Le, Q.| Singh, P.| Pham, T.-H.| Kim, T.| Ghotekar, S.| Nguyen, V.-H.	2022	Chemical Engineering Journal
14	Emerging cocatalysts in TiO2-based photocatalysts for light-driven catalytic hydrogen evolution: Progress and perspectives	Xia, C.| Hong Chuong Nguyen, T.| Cuong Nguyen, X.| Young Kim, S.| Nguyen, D.L.T.| Raizada, P.| Singh, P.| Nguyen, V.-H.| Chien Nguyen, C.| Chinh Hoang, V.| Van Le, Q.	2022	Fuel
15	ZnO-based heterostructures as photocatalysts for hydrogen generation and depollution: a review	Dhiman, P.| Rana, G.| Kumar, A.| Sharma, G.| Vo, D.-V.N.| Naushad, M.	2022	Environmental Chemistry Letters
16	Regional Sustainable Development and Spatial Effects From the Perspective of Renewable Energy	Cai, X.| Wang, W.| Rao, A.| Rahim, S.| Zhao, X.	2022	Frontiers in Environmental Science
17	CO2 photoreduction into solar fuels via vacancy engineered bismuth-based photocatalysts:	Kumar, A.| Singh, P.| Khan, A.A.P.| Le, Q.V.| Nguyen, V.-H.|	2022	Chemical Engineering Journal

	Selectivity and mechanistic insights	Thakur, S.| Raizada, P.		
18	Revisting conventional and green finance spillover in post-COVID world: Evidence from robust econometric models	Sharma, G.D.| Sarker, T.| Rao, A.| Talan, G.| Jain, M.	2022	Global Finance Journal
19	Impact of artificial roughness variation on heat transfer and friction characteristics of solar air heating system	kumar, R.| Kumar, R.| Kumar, S.| Thapa, S.| Sethi, M.| Fekete, G.| Singh, T.	2022	Alexandria Engineering Journal
20	Recent advances in hydrochar application for the adsorptive removal of wastewater pollutants	Ighalo, J.O.| Rangabhashiyam, S.| Dulta, K.| Umeh, C.T.| Iwuozor, K.O.| Aniagor, C.O.| Eshiemogie, S.O.| Iwuchukwu, F.U.| Igwegbe, C.A.	2022	Chemical Engineering Research and Design
21	Properties, synthesis, and recent advancement in photocatalytic applications of graphdiyne: A review	Shandilya, P.| Mandyal, P.| Kumar, V.| Sillanpää, M.	2022	Separation and Purification Technology
22	Production and harvesting of microalgae and an efficient operational approach to biofuel production for a sustainable environment	Khan, S.| Naushad, M.| Iqbal, J.| Bathula, C.| Sharma, G.	2022	Fuel
23	Valorisation of xylose to renewable fuels and chemicals, an essential step in augmenting the commercial viability of lignocellulosic biorefineries	Narisetty, V.| Cox, R.| Bommareddy, R.| Agrawal, D.| Ahmad, E.| Pant, K.K.| Chandel, A.K.| Bhatia, S.K.| Kumar, D.| Binod, P.| Gupta, V.K.| Kumar, V.	2022	Sustainable Energy and Fuels
24	Strategies based review on near-infrared light-driven bismuth nanocomposites for environmental pollutants degradation	Sudhaik, A.| Parwaz Khan, A.A.| Raizada, P.| Nguyen, V.-H.| Van Le, Q.| Asiri, A.M.| Singh, P.	2022	Chemosphere

25	Challenges and perspectives on innovative technologies for biofuel production and sustainable environmental management	Khan, S.| Naushad, M.| Iqbal, J.| Bathula, C.| Al-Muhtaseb, A.H.	2022	Fuel
26	The environmental impact of mass coronavirus vaccinations: A point of view on huge COVID-19 vaccine waste across the globe during ongoing vaccine campaigns	Hasija, V.| Patial, S.| Raizada, P.| Thakur, S.| Singh, P.| Hussain, C.M.	2022	Science of the Total Environment
27	Resolving energy poverty for social change: Research directions and agenda	Shahzad, U.| Gupta, M.| Sharma, G.D.| Rao, A.| Chopra, R.	2022	Technological Forecasting and Social Change
28	Activated Carbon as Superadsorbent and Sustainable Material for Diverse Applications	Sharma, G.| Sharma, S.| Kumar, A.| Lai, C.W.| Naushad, M.| Shehnaz| Iqbal, J.| Stadler, F.J.	2022	Adsorption Science and Technology
29	MXenes based nano-heterojunctions and composites for advanced photocatalytic environmental detoxification and energy conversion: A review	Sharma, S.K.| Kumar, A.| Sharma, G.| Vo, D.-V.N.| García-Peñas, A.| Moradi, O.| Sillanpää, M.	2022	Chemosphere
30	Influence of pyrolysis conditions of modified corn cob bio-waste sorbents on adsorption mechanism of atrazine in contaminated water	Binh, Q.A.| Nguyen, V.-H.| Kajitvichyanukul, P.	2022	Environmental Technology and Innovation
31	Strategies and perspectives of tailored SnS2 photocatalyst for solar driven energy applications	Sharma, K.| Patial, S.| Singh, P.| Khan, A.A.P.| Saini, V.| Nadda, A.K.| Hussain, C.M.| Nguyen, V.-H.| Nguyen, C.C.| Hac Nguyen, T.B.| Kim, S.Y.| Le, Q.V.| Raizada, P.	2022	Solar Energy

32	Progress in valorisation of agriculture, aquaculture and shellfish biomass into biochemicals and biomaterials towards sustainable bioeconomy	Wan Mahari, W.A.| Waiho, K.| Fazhan, H.| Necibi, M.C.| Hafsa, J.| Mrid, R.B.| Fal, S.| El Arroussi, H.| Peng, W.| Tabatabaei, M.| Aghbashlo, M.| Almomani, F.| Lam, S.S.| Sillanpää, M.	2022	Chemosphere
33	Influence of artificial roughness parametric variation on thermal performance of solar thermal collector: An experimental study, response surface analysis and ANN modelling	Kumar, R.| Nadda, R.| Kumar, S.| Razak, A.| Sharifpur, M.| Aybar, H.S.| Ahamed Saleel, C.| Afzal, A.	2022	Sustainable Energy Technologies and Assessments
34	Biochar-microorganism interactions for organic pollutant remediation: Challenges and perspectives	Mukherjee, S.| Sarkar, B.| Aralappanavar, V.K.| Mukhopadhyay, R.| Basak, B.B.| Srivastava, P.| Marchut-Mikołajczyk, O.| Bhatnagar, A.| Semple, K.T.| Bolan, N.	2022	Environmental Pollution
35	Recent progress and challenges in photocatalytic water splitting using layered double hydroxides (LDH) based nanocomposites	Shandilya, P.| Sharma, R.| Arya, R.K.| Kumar, A.| Vo, D.-V.N.| Sharma, G.	2022	International Journal of Hydrogen Energy
36	Production of hydrogen and value-added carbon materials by catalytic methane decomposition: a review	Pham, C.Q.| Siang, T.J.| Kumar, P.S.| Ahmad, Z.| Xiao, L.| Bahari, M.B.| Cao, A.N.T.| Rajamohan, N.| Qazaq, A.S.| Kumar, A.| Show, P.L.| Vo, D.-V.N.	2022	Environmental Chemistry Letters

37	Performance analysis outcome of a 19-MWp commercial solar photovoltaic plant with fixed-tilt, adjustable-tilt, and solar tracking configurations	Chandel, R.| Chandel, S.S.	2022	Progress in Photovoltaics: Research and Applications
38	An experimental analysis of enhancing efficiency of photovoltaic modules using straight and zigzag fins	Firoozzadeh, M.| Shiravi, A.H.| Chandel, S.S.	2022	Journal of Thermal Analysis and Calorimetry
39	A review study on the performance of a parabolic trough receiver using twisted tape inserts	Thapa, S.| Samir, S.| Kumar, K.	2022	Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering
40	Tailoring of structural, optical and electrical properties of anatase TiO2 via doping of cobalt and nitrogen ions	Sharma, A.| Negi, P.| Konwar, R.J.| Kumar, H.| Verma, Y.| Shailja| Sati, P.C.| Rajyaguru, B.| Dadhich, H.| Shah, N.A.| Solanki, P.S.	2022	Journal of Materials Science and Technology
41	Novel step-scheme (S-scheme) heterojunction photocatalysts toward artificial photosynthesis	Nguyen, V.-H.| Singh, P.| Sudhaik, A.| Raizada, P.| Le, Q.V.| Helmy, E.T.	2022	Materials Letters
42	Experimental investigation and optimization of potential parameters of discrete V down baffled solar thermal collector using hybrid Taguchi-TOPSIS method	Sharma, A.| Awasthi, A.| Singh, T.| Kumar, R.| Chauhan, R.	2022	Applied Thermal Engineering
43	Environmental Pollution Remediation via Photocatalytic Degradation of Sulfamethoxazole from Waste Water Using Sustainable Ag2S/Bi2S3/g-C3N4 Nano-Hybrids	Kumar, A.| Sharma, G.| Naushad, M.| ALOthman, Z.A.| Dhiman, P.	2022	Earth Systems and Environment
44	Energy recovery prospects of fuel cell technologies: sustainability and bioremediation	Bose, D.| Mukherjee, A.| Mitra, G.	2022	Australian Journal of Mechanical Engineering

45	Assessment of the Thermo-Hydraulic Efficiency of an Indoor-Designed Jet Impingement Solar Thermal Collector Roughened with Single Discrete Arc-Shaped Ribs	Kumar, R.| Cuce, E.| Kumar, S.| Thapa, S.| Gupta, P.| Goel, B.| Saleel, C.A.| Shaik, S.	2022	Sustainability (Switzerland)
46	Recent developments in design of evacuated tube solar collectors integrated with thermal energy storage: A review	Sethi, M.| Tripathi, R.K.| Pattnaik, B.| Kumar, S.| Khargotra, R.| Chand, S.| Thakur, A.	2022	Materials Today: Proceedings
47	An overview of SnO2 based Z scheme heterojuctions: Fabrication, mechanism and advanced photocatalytic applications	Chawla, A.| Sudhaik, A.| Raizada, P.| Khan, A.A.P.| Singh, A.| Van Le, Q.| Van Huy Nguyen| Ahamad, T.| Alshehri, S.M.| Asiri, A.M.| Singh, P.	2022	Journal of Industrial and Engineering Chemistry
48	Thermo-hydraulic characterization and design optimization of delta-shaped obstacles in solar water heating system using CRITIC-COPRAS approach	Khargotra, R.| Kumar, R.| András, K.| Fekete, G.| Singh, T.	2022	Energy
49	Emerging new-generation covalent organic frameworks composites as green catalysts: design, synthesis and solar to fuel production	Patial, S.| Raizada, P.| Aslam Parwaz Khan, A.| Singh, A.| Van Le, Q.| Huy Nguyen, V.| Selvasembian, R.| Mustansar Hussain, C.| Singh, P.	2022	Chemical Engineering Journal
50	Metallic and bimetallic phosphides-based nanomaterials for photocatalytic hydrogen production and water detoxification: a review	Kumar, A.| Shandilya, P.| Vo, D.-V.N.| Sharma, G.| Naushad, M.| Dhiman, P.| Stadler, F.J.	2022	Environmental Chemistry Letters
51	Recent advances in two-dimensional MXenes for power and smart energy systems	Thakur, N.| Kumar, P.| Sati, D.C.| Neffati, R.| Sharma, P.	2022	Journal of Energy Storage

52	Performance evaluation of solar parabolic trough receiver using multiple twisted tapes with circular perforation and delta winglet	Thapa, S.| Samir, S.| Kumar, K.	2022	Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering
53	Perspective of new distributed grid connected roof top solar photovoltaic power generation policy interventions in India	Chandel, R.| Chandel, S.S.| Malik, P.	2022	Energy Policy
54	Phytochemically stabilized chitosan encapsulated Cu and Ag nanocomposites to remove cefuroxime axetil and pathogens from the environment	Bhatia, N.| Kumari, A.| Thakur, N.| Sharma, G.| Singh, R.R.| Sharma, R.	2022	International Journal of Biological Macromolecules
55	Thermo-hydraulic efficiency and correlation development of an indoor designed jet impingement solar thermal collector roughened with discrete multi-arc ribs	Kumar, R.| Kumar, S.| Nadda, R.| Kumar, K.| Goel, V.	2022	Renewable Energy
56	Microwave-assisted pretreatment of harmful algal blooms for microbial oil-centered biorefinery approach	Kumar, V.| Arora, N.| Pandey, S.| Jaiswal, K.K.| Nanda, M.| Vlaskin, M.S.| Chauhan, P.K.	2022	Biomass Conversion and Biorefinery
57	Influence of Active Water Stream, Irradiance, Ambient Temperature, and Wind Speed on The Efficiency of Fresnel Lens Based Two Stage Pvt System	Singhy, A.| Thakur, R.| Kumar, R.| Kumar, S.| Kumar, S.| Kumar, S.| Thapa, S.	2022	Thermal Science
58	A dual-functional integrated Ni5P4/g-C3N4 S-scheme heterojunction for high performance synchronous photocatalytic hydrogen evolution and multi-contaminant removal with a waste-to-energy conversion	Lin, X.| Kumar, A.| Sharma, G.| Naushad, M.| Alberto García-Peñas| Stadler, F.J.	2022	Journal of Molecular Liquids
59	Bio-Inspired Synthesis of Carbon-Based Nanomaterials and Their Potential Environmental Applications: A State-of-the-Art Review	Dutta, V.| Verma, R.| Gopalkrishnan, C.| Yuan, M.-H.| Batoo, K.M.| Jayavel, R.| Chauhan, A.| Lin, K.-Y.A.|	2022	Inorganics

		Balasubramani, R.| Ghotekar, S.		
60	Recent advancements in the synthesis and electrocatalytic activity of two-dimensional metal–organic framework with bimetallic nodes for energy-related applications	Soni, I.| Kumar, P.| Kudur Jayaprakash, G.	2022	Coordination Chemistry Reviews
61	Emerging chemo-biocatalytic routes for valorization of major greenhouse gases (GHG) into industrial products: A comprehensive review	Sharma, K.| Park, Y.-K.| Nadda, A.K.| Banerjee, P.| Singh, P.| Raizada, P.| Banat, F.| Bharath, G.| Jeong, S.M.| Lam, S.S.	2022	Journal of Industrial and Engineering Chemistry
62	Utilization of biodegradable novel insulating materials for developing indigenous solar water heater for hill climates	Kaur, S.| Konwar, R.J.| Negi, P.| Dhar, S.| Singh, K.| Chandel, S.S.	2022	Energy for Sustainable Development
63	Metal-organic-framework based catalyst for hydrogen production: Progress and perspectives	Do, H.H.| Nguyen, T.H.C.| Nguyen, T.V.| Xia, C.| Nguyen, D.L.T.| Raizada, P.| Singh, P.| Nguyen, V.-H.| Ahn, S.H.| Kim, S.Y.| Le, Q.V.	2022	International Journal of Hydrogen Energy
64	Melatonin enhanced oilseed rape growth and mitigated Cd stress risk: A novel trial for reducing Cd accumulation by bioenergy crops	Menhas, S.| Yang, X.| Hayat, K.| Ali, A.| Ali, E.F.| Shahid, M.| Shaheen, S.M.| Rinklebe, J.| Hayat, S.| Zhou, P.	2022	Environmental Pollution
65	Internet of Things-Based Crop Classification Model Using Deep Learning for Indirect Solar Drying	Sharma, B.B.| Gupta, G.| Vaidya, P.| Basheer, S.| Memon, F.H.| Thakur, R.N.	2022	Wireless Communications and Mobile Computing

66	A comprehensive study on piezo-phototronic effect for increasing efficiency of solar cells: A review	Verma, R.| Chauhan, A.| Kalia, R.| Jasrotia, R.| Sharma, M.| Kumar, R.	2022	Optics and Laser Technology
67	Applications of Microbial Fuel Cell Technology and Strategies to Boost Bioreactor Performance	Maqsood, Q.| Ameen, E.| Mahnoor, M.| Sumrin, A.| Akhtar, M.W.| Bhattacharya, R.| Bose, D.	2022	Nature Environment and Pollution Technology
68	Review on thermoelectric systems for enhancing photovoltaic power generation	Chandel, R.| Singh Chandel, S.| Prasad, D.| Prakash Dwivedi, R.	2022	Sustainable Energy Technologies and Assessments
69	Mechano-chemical and biological energetics of immobilized enzymes onto functionalized polymers and their applications	Sharma, T.| Xia, C.| Sharma, A.| Raizada, P.| Singh, P.| Sharma, S.| Sharma, P.| Kumar, S.| Lam, S.| Nadda, A.K.	2022	Bioengineered
70	Study on the effect of electrode configuration on the performance of a hydrogen/vanadium redox flow battery	Hsu, N.-Y.| Devi, N.| Lin, Y.-I.| Hu, Y.-H.| Ku, H.-H.| Arpornwichanop, A.| Chen, Y.-S.	2022	Renewable Energy
71	Plasmon assisted optical absorption and reduced charge recombination for improved device performance in polymer solar cell	Ike, J.N.| Dlamini, M.W.| Dwivedi, R.P.| Zhang, Y.| Mola, G.T.	2022	Journal of Physics and Chemistry of Solids
72	Identification & Prioritisation of Barriers in the Growth of Pine Needle Biomass Gasification Plants (< 250 kW) for Electricity Generation in the Western Himalayan Region: Uttarakhand, India	Bisht, A.S.| Thakur, N.S.	2022	Process Integration and Optimization for Sustainability
73	Feasibility analysis for conversion of existing traditional watermills in Western Himalayan region of India to micro-hydropower plants using a low head	Kashyap, K.| Thakur, R.| Kumar, R.| Kumar, S.	2022	International Journal of Ambient Energy

	Archimedes screw turbine for rural electrification			
74	Enhanced Heat Transfer Using Oil-Based Nanofluid Flow through Conduits: A Review	Kumar, S.| Sharma, M.| Bala, A.| Kumar, A.| Maithani, R.| Sharma, S.| Alam, T.| Gupta, N.K.| Sharifpur, M.	2022	Energies
75	SOLAR DRYING OF HERBAL WEALTH IN EASTERN HIMALAYA: A REVIEW	Chauhan, P.| Pathania, H.| Shriya| Neetika| Nidhi| Sakshi| Choudhary, S.| Kumar, R.| Sharma, M.| Rahatekar, S.| Kumar, A.	2022	Frontiers in Heat and Mass Transfer
76	Recent development of graphene-based composite for multifunctional applications: energy, environmental and biomedical sciences	Devi, N.| Kumar, R.| Singh, S.| Singh, R.K.	2022	Critical Reviews in Solid State and Materials Sciences
77	A Facile and Sustainable Enhancement of Anti-Oxidation Stability of Nafion Membrane	Sharma, P.P.| Kim, D.	2022	Membranes
78	Effects of dust on the performance of solar panels – a review update from 2015–2020	Saini, R.K.| Saini, D.K.| Gupta, R.| Verma, P.| Dwivedi, R.P.| Kumar, A.| Chauhan, D.| Kumar, S.	2022	Energy and Environment
79	Selection of optimal parameters using PSI approach of a dimpled-V pattern roughened solar heat collector	Priyanka| Kumar, S.| Kumar, A.| Maithani, R.	2022	Materials Today: Proceedings
80	Biohydrogen production and its bioeconomic impact: a review	Dulta, K.| Adeola, A.O.| Ashaolu, S.E.| Banji, T.I.| Ighalo, J.O.	2022	Waste Disposal and Sustainable Energy
81	Conductivity Study on Proton-Conducting Nanocomposite Plasticized Polymer Electrolytes: A Review	Sharma, S.| Pathak, D.| Dhiman, N.| Kumar, R.| Prashar, K.K.|	2022	Current Materials Science

		Kahol, M.| Arora, N.| Sharma, V.		
82	Efficiency enhancement in Archimedes screw turbine by varying different input parameters - An experimental study	Kumar Thakur, N.| Thakur, R.| Kashyap, K.| Goel, B.	2022	Materials Today: Proceedings
83	Vetiver Grass Environmental Model for Rehabilitation of Iron Overburden Soil: An Ecosystem Service Approach	Vimala, Y.| Lavania, U.C.| Banerjee, R.| Lavania, S.| Mukherjee, A.	2022	National Academy Science Letters
84	A Novel Metaheuristic Approach for Solar Photovoltaic Parameter Extraction Using Manufacturer Data	Tajjour, S.| Chandel, S.S.| Malik, H.| Alotaibi, M.A.| Ustun, T.S.	2022	Photonics
85	Improving the redox performance of photocatalytic materials by cascade-type charge transfer: a review	Sharma, K.| Kumar, A.| Ahamad, T.| Alshehri, S.M.| Singh, P.| Thakur, S.| Van Le, Q.| Wang, C.| Huynh, T.-T.| Nguyen, V.-H.| Raizada, P.	2022	Environmental Chemistry Letters
86	Study on the Self-Discharge of an All-Vanadium Redox Flow Battery through Monitoring Individual Cell Voltages	Chou, Y.-S.| Devi, N.| Yen, S.-C.| Singh, P.| Chen, Y.-S.	2022	ACS Sustainable Chemistry and Engineering
87	INFLUENCE OF DISTINCT INSERTS ON THE THERMAL AUGMENTATION OF NANOFLUID-BASED HEAT EXCHANGER: A COMPREHENSIVE REVIEW ON SOLARASSISTED TECHNOLOGY	Thapa, S.| Kumar, R.| Kumar, K.| Thakur, R.| Rana, R.	2022	Nanotechnology Applications in Green Energy Systems
88	Prospects of sustainable photovoltaic powered thermoelectric cooling in zero energy buildings: A review	Chandel, R.| Chandel, S.S.| Prasad, D.| Dwivedi, R.P.	2022	International Journal of Energy Research
89	Solar Energy in Nigeria - Status, Utility and Procurement	Kashyap, K.| Sani, M.A.| Kumar, S.| Kumar, N.|	2022	ECS Transactions

		Kumar, N.| Thakur, R.		
90	A brief review to improve the efficiency of solar still using efficient phase change materials	Thakur, V.| Kumar, N.| Kumar, S.| Kumar, N.	2022	Materials Today: Proceedings
91	Non-Noble Metal Ion-Based Metal-Organic Framework Electrocatalyst for Electrochemical Hydrogen Generation	Prakash, S.| Kamlesh| Tanwar, D.| Raizda, P.| Singh, P.| Mudgal, M.| Srivastava, A.K.| Singh, A.	2022	Green Energy Harvesting: Materials for Hydrogen Generation and Carbon Dioxide Reduction
92	A novel design for humidifying an open-cathode proton exchange membrane fuel cell using anode purge	Le, P.-L.| Devi, N.| Chou, J.| Arpornwichanop, A.| Chen, Y.-S.	2022	International Journal of Hydrogen Energy
93	Enhanced bioenergy and nutrients recovery from wastewater using hybrid anodes in microbial nutrient recovery system	Shahid, K.| Ramasamy, D.L.| Kaur, P.| Sillanpää, M.| Pihlajamäki, A.	2022	Biotechnology for Biofuels and Bioproducts
94	Radiative heat transfer due to solar radiation in MHD Sisko nanofluid flow	Bisht, A.| Bisht, A.S.	2022	Heat Transfer
95	Synthesis methods and magnetic properties of magnesium ferrites: A short review	Kumari, N.| Jasrotia, R.| Kour, S.| Neha| Singh, Y.| Kumar, R.	2022	AIP Conference Proceedings
96	New energy harvesting using conjugated chalconyl-organosiloxyl framework	Singh, G.| Satija, P.| Lin, F.-S.| Pawan| Mohit| Sushma| Priyanka| Kaur, J.| Ho, K.-C.	2022	Materials Chemistry and Physics
97	A comprehensive review of four decades of thermally efficient biomass cookstove initiatives for sustainable development in India	Aggarwal, R.K.| Chandel, S.S.	2022	International Journal of Ambient Energy
98	Mixed ionic-electronic conducting (MIEC) oxide ceramics for electrochemical applications	Devi, N.| Singh, B.| Song, S.-J.	2022	Advanced Ceramics for Versatile Interdisciplinary Applications
99	Miniaturization devices: A nanotechnological approach	Thakur, N.| Das, T.R.| Patra, S.| Choudhary, M.| Shukla, S.K.	2022	Electrochemical Sensors: From Working Electrodes to Functionalization and Miniaturized Devices

100	IoT-based systems for COVID-19 like pandemic screening	Kumar, A.| Maharana, A.| Thakur, N.	2022	Mobile Health: Advances in Research and Applications - Volume II
101	A first principle study on spin-dependent transport properties of graphite nanostructures	Jara, A.D.| Verma, R.| Chauhan, A.| Saha, A.| Singh, Y.| Kumar, R.	2022	AIP Conference Proceedings
102	Exergy analysis of various solar thermal collectors	Priyanka| Kumar, S.| Kumar, A.| Maithani, R.| Sharma, S.| Singh, D.	2022	Materials Today: Proceedings
103	Comparative analysis of dusty and clean photovoltaic panels	Pandey, A.| Chauhan, A.| Ghoshal, S.| Singh, V.P.| Singh, Y.| Kumar, R.	2022	AIP Conference Proceedings
104	Constructing effective ion channels in anion exchange membranes via exfoliated nanosheets towards improved conductivity for alkaline fuel cells	Sharma, P.P.| Manohar, M.| Kim, D.	2022	Materials Advances
105	Block freeze concentration by centrifugation and vacuum increases the content of lactose-free milk macronutrients	Dantas, A.| Orellana-Palma, P.| Kumar, D.| Hernandez, E.| Prudencio, E.S.	2022	Journal of Food Science

Annexure-II: *List of Patents in Energy granted in 2022*

Title	Inventors	Patent No.	Date	Department	Status
SOLAR-POWERED MAGNETIC STIRRER SYSTEM	Mr. Sunil Kumar Dr. Deepak Kumar	**202211011865**	04-Mar-22	Pharmacy	Complete application
TRIPLE SOLAR PANEL BASED SPRAY PUMP SYSTEM	Dr. Arshdeep Singh,Dr. Anurag Kumar,Dr. Sanchit Thakur,Dr. Shimpy Sarkar	**202211013155**	10-Mar-22	Agriculture	Complete application
SOLAR POWERED REFLUX CONDENSATION REACTION APPARATUS	Sunil Kumar,Dr. Deepak Kumar	**202211013838**	14-Mar-22	Pharmacy	Complete application
A SMART SOLAR STREET LAMP	Dr. Ritesh Verma, Prof. Rajesh Kumar , Dr. Ankush Chauhan, Mr. Rahul Kalia	**202211024758**	27-Apr-22	Physics	Complete application
SOLAR POWERED DIGITAL WEIGHING MACHINE	Dr. Kamal Dev,Dr. Anuradha Sourirajan	**202211034798**	17-Jun-22	Biotech	Complete application
SOLAR POWERED PORTABLE WEIGHING MACHINE	Dr. Kamal Dev , Dr. Anuradha Sourirajan	**202211034795**	17-Jun-22	Biotech	Complete application
A SOLAR POWERED SPRAYER	Dr. Amit Kumar	**202211034796**	17-Jun-22	Agriculture	Complete application
SOLAR DISH STIRLING PUMP SYSTEM	Qusai Alkhalaf,Arvind Singh Bisht, Amar Raj Singh, Suri Sham Singh Chandel	**202211049153**	29-Aug-22	Engineering	Complete application
SOLAR POWERED	Dr. Kamal Dev, Dr. Anuradha Sourirajan	**202211055222**	27-Sep-22	Biotech	Complete application

INDUCTION COOK TOP					
SOLAR POWERED OVEN	Dr. Kamal Dev, Dr. Anuradha Sourirajan	**202211055220**	27-Sep-22	Biotech	Complete application
SOLAR POWERED SPEED BOAT	Dr. Kamal Dev, Dr. Anuradha Sourirajan	**202211055223**	27-Sep-22	Biotech	Complete application
SOLAR POWERED MOBILE CHARGER	Dr. Kamal Dev, Dr. Anuradha Sourirajan	**202211055221**	27-Sep-22	Biotech	Complete application