SHIV NADAR
INSTITUTION OF EMINENCE DEEMED TO BE
UNIVERSITY
DELHI NCR

# Report on Sustainable Development

## GOAL 7

## AFFORDABLE AND CLEAN ENERGY

Ensure access to affordable, reliable, sustainable, and modern energy for all

Sustainable Development Goal 7 has five targets and seven indicators that address the growing **energy** demand and an urgent need to mitigate climate change. It is about access to clean and affordable energy.

At Shiv Nadar Institution of Eminence, energy is one of the priority research areas. We contribute to SDG 7 through teaching and research related to clean and alternate energy sources.

We have also taken significant steps on campus toward environmental sustainability through clean energy initiatives, waste management practices, energy conservation measures and collaborate with stakeholders to positively impact the local community at large.

Here we highlight some key initiatives.

## 1 Teaching and Learning

The university offers many courses on new and alternate sources of energy. The Department of Mechanical Engineering offers a course on the Fundamentals of hydrogen fuel cell technology (MED 324), which addresses the need to understand the hydrogen economy and its importance as an alternative energy source. The School of Natural Sciences and the School of Engineering offer courses like Non-conventional energy resources (MED 311), Energy conversion technology and energy management (MED 413), Green chemistry and sustainability (CHY 554), Solar energy (MED 403), and Green energy studies (MED 508). Undergraduate students are offered compulsory courses, such as Energy for sustainable future (CCC 614), Use of energy in our daily life (CCC 624), and Green energy technologies (CCC613).

### Development of efficient electrocatalysts for hydrogen generation

A Ph.D. student working with Dr. Harpreet Singh Arora, Professor and Head of Department of Mechanical Engineering is developing efficient electrocatalysts for hydrogen generation through overall water splitting, which is considered one of the cleanest and eco-friendly techniques for

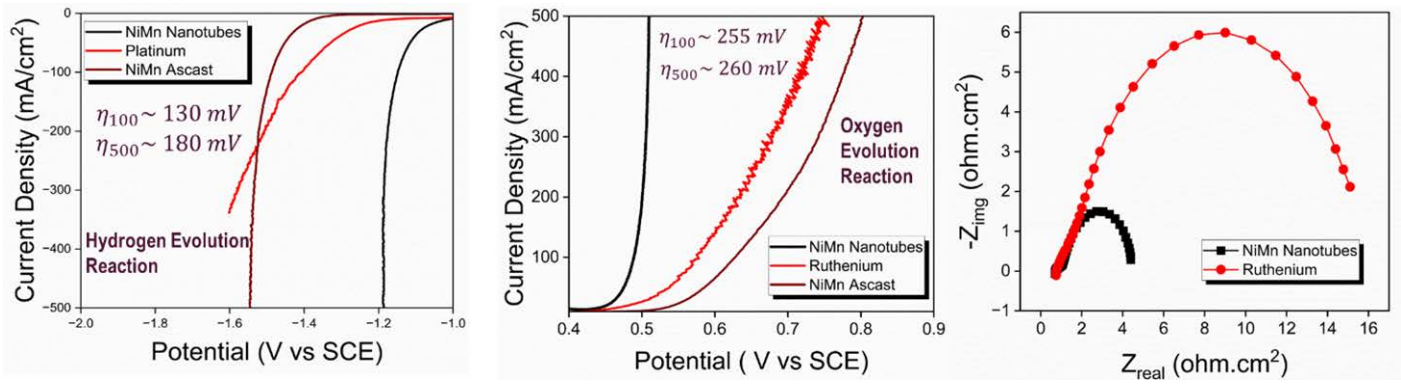



**Figure 1:** Linear Scan Voltammetry (LSV) and Electrochemical Impedance Spectroscopy (EIS) curves for NiMn As-cast, NiMn nanotubes, Platinum, and Ruthenium oxide.

hydrogen production. This is a novel processing technique that uses short burst of physical deformation along with selective de-alloying (SD) deployed to synthesize unique nano-tubular NiMn-oxy (hydroxide) structures (NTSD). The project demonstrates an outstanding electrochemical performance of bi-functional nano-tubular NiMn-(oxy) hydroxide for overall water splitting (Figure 1). It is a unique perspective for developing highly effective catalysts using a top-down approach, which can be extended to a wide range of material systems.

### Developing high-performance energy storage devices

Two Ph.D. students at the Department of Mechanical Engineering are developing high-performance energy storage devices. Their work focuses on synthesizing energy-dense devices without compromising power density and life cycle. The research involves an in-situ synthesis of a nano-textured active layer over the current collector through techniques that can directly be used for energy storage and catalysis applications.

## 2 Research

At Shiv Nadar, many faculty and researchers are working on path-breaking research related to alternate and green energy. Here we highlight some exciting research projects by the faculty.

### Cutting-edge research in energy studies

Dr. Harpreet Singh Grewal, Dr. Harpreet Singh Arora, and Dr. Sumit Tiwari from the Department of Mechanical Engineering were featured in Stanford University's top 2% of Scientists list. Stanford University released a list identifying the top 2% of the most-cited scientists in various disciplines. Dr. Harpreet Singh Grewal, Dr. Harpreet Singh Arora, Associate Professors in the Department of


Mechanical Engineering, and Dr. Sumit Tiwari, Assistant Professor in the Department of Mechanical Engineering, have been included in the list of scientists who have excelled in research in the fields of Material Science and Energy. Dr. Arora's research interests include using different surface engineering approaches, including Friction stir processing and advanced materials for addressing material degradation, Energy storage, and the development of Supercapacitors. Through advanced materials and processing techniques, Dr. Grewal's research involves developing bio-inspired superhydrophobic self-cleaning metallic and polymer surfaces with tuned wetting, adhesion, and frictional properties. Dr. Tiwari works on the development of other solar thermal technologies, namely, photovoltaic thermal (PVT) greenhouse drying systems, PVT greenhouse heating systems, PVT greenhouse biogas heating systems, solar still, PVT air collectors, PVT air collector integrated drying systems, passive cooling of the building, and solar adsorption cooling systems.

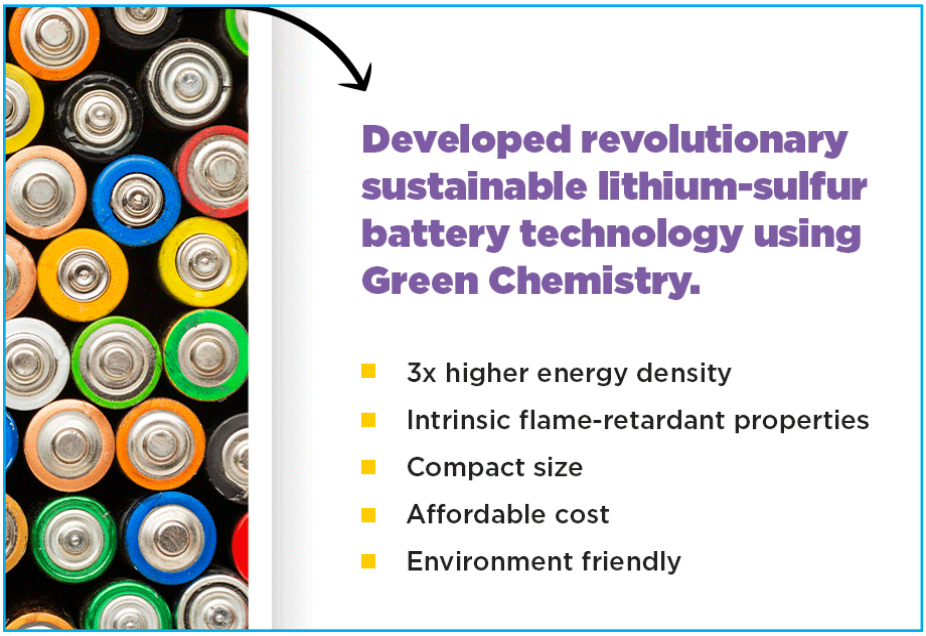
### India's first sustainable Lithium-Sulfur battery technology

Dr. Bimlesh Lochab, Professor and Head at the Department of Chemistry, has developed a new battery technology that incorporates by-products from the petroleum industry (sulfur), agro-waste elements, and copolymers such as cardanol (a by-product of cashew nut processing) and eugenol (clove oil) as cathodic materials.

The research developed sulfur copolymers as an alternative cathode material that maximizes energy storage while prioritizing safety in Lithium-Sulfur (Li-S) batteries. Once put into production, this Li-S battery technology will be significantly cheaper and sustainable, offering up to three times higher energy density with intrinsic flame-retardant properties.

### Clean technology

Dr. Sumit Tiwari, Assistant Professor, Department of Mechanical Engineering is conducting research



to address the problem of preserving food supply in the face of increasing food production. The study proposes ancient practices of sun drying to preserve harvests, vegetables, and fruits instead of dryers that demand high energy and are obtained by burning fossil fuels. Examining a variety of sun-drying devices available in designs, their method of construction, and operating ideologies, the study advocates hybrid photovoltaic thermal solar dryer due to its high electrical and thermal efficiency, sound mitigation of carbon dioxide levels, that give high drying rate and less payback time. An efficient photovoltaic solar dryer collector system can be economical with good electrical and thermal efficiency for large-scale applications.

## Dedicated Laboratories

**Energy and Environmental Sustainability Lab:** Lab is dedicated to utilizing the agro-industrial solid waste and food waste obtained from the food mess, restaurants, etc., for various purposes, such as bio-oil production using thermochemical conversion methods and wastewater treatment. Bio-oil is upgraded to biodiesel and value-added chemicals to make it refined for direct use.

**Solar Energy UG Lab:** Lab provides knowledge on the importance of available solar energy and its capabilities for various applications. Equipment like flat plate collectors, evacuated tube collectors, and solar cookers are used to train undergraduate students. The research aims to develop and achieve self-sustainable, eco-friendly solar energy systems for various applications. Research on solar integrated cooling, Solar Desalination, Thermal Energy Storage, and Solar drying is carried out.

**Waste to Wealth Lab:** Lab is dedicated to bioenergy production from the thermochemical conversion process and then characterizes the different forms of energy, including biochar, bio-oil, and syngas.

**Sustainability & Polymer Laboratory:** Research activities in this lab are broadly aligned to address global climate challenges. The 'sustainability' objective focuses on reducing the carbon footprint of industries (a) By developing high entropy materials to improve the efficiency and lifetime of machinery that undergo multiple cycles of heating to high temperatures and cooling to atmospheric conditions and (b) By developing superior and green absorbents and adsorbents for pre- and post-combustion carbon dioxide capture. The 'polymer' objective focuses on developing next-generation biodegradable films for food packaging applications from biodegradable polymers and additives.

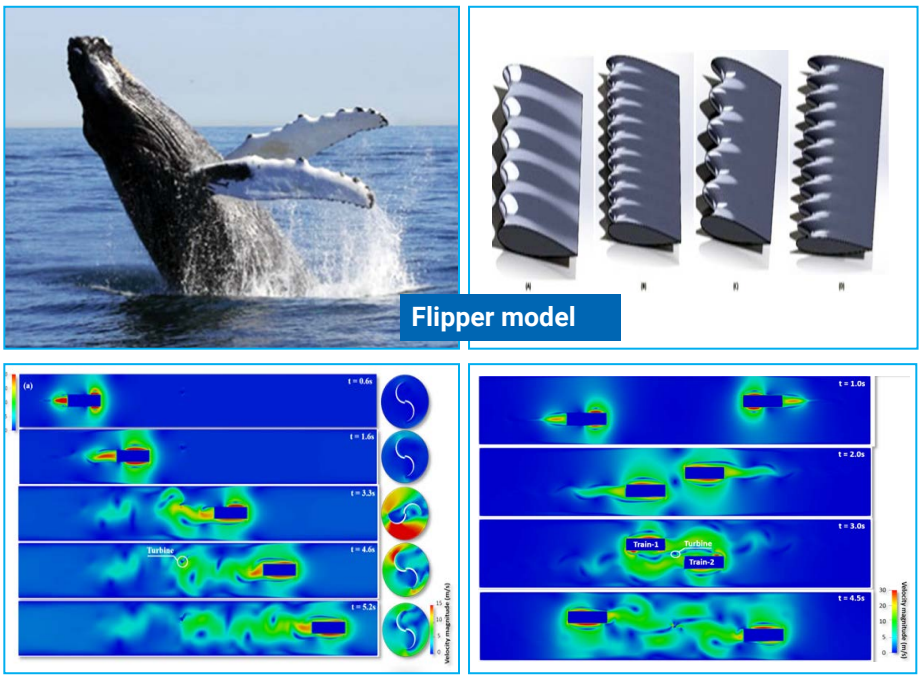



**Figure:** Flow characteristics when the vehicle passes the turbine

**This research work was published in JERT, ASME, and part of the work was published in the Renewable Energy journal**

## An environmentally compatible organic solar cells (OSC)

An environmentally compatible organic solar cells (OSC) have the potential to build a global clean energy infrastructure for the world. The research demonstrates a rational approach to synthesize and develop green organic semiconductors using bio feedstock-derived materials to realize efficient and environmentally compatible OSCs. The research reports a rational design, synthesis, and characterization of the donor (D)-acceptor (A)-based green organic small molecules, consisting of difluoro-2,1,3-benzothiadiazole (BTF2) as the acceptor, with thiophene (T) and renewable resource materials, cardanol (C) and guaiacol (G) as the donor materials. The reference molecule, abbreviated as T4BTF2, is fully petro-sourced, while C2T2BTF2 and G2T2BTF2 are partly renewable origin molecules.

**Rajkumar, Barla, Lubna Khanam, Emmanuel N. Koukaras, Ganesh D. Sharma, Samarendra P. Singh, and Bimlesh Lochab.** "Cardanol- and Guaiacol-Sourced Solution-Processable Green Small Molecule-Based Organic Solar Cells." ACS Sustainable Chemistry & Engineering 8, no. 15 (2020): 5891-5902.

## Technology to harvest green power

The Department of Mechanical Engineering has designed and

fabricated wind turbine blades for efficiently converting wind energy to electrical power. The work introduces the novel concept of testing a vertical axis wind turbine with dimple or tubercle structures on its blades and investigates its effect on the turbine's efficiency. The tubercle profile increased the separation length, decreased the wake region, and, subsequently, the drag. Thus, modifying the turbine's leading, trailing edge, and end tip which led to higher efficiency. The study results have shown the potential of increased power coefficient by adding dimple structures on the blades. Thus, harvesting energy from both ambient wind and wind produced by moving vehicles. The research has been validated by 'Renewable Energy' (Impact factor–8.7).

## 3 University Operations

At Shiv Nadar, we are taking measures to conserve energy and reduce greenhouse gas emissions. We have set policies to ensure all new infrastructure follow energy standards. This includes a comprehensive Environment, Health, and Safety (EHS) policy and ISO 14001:2015 accreditations since 2019. All planning and development policies for sustainable campus operations and processes flow from EHS policy, thus, minimizing any adverse environmental impact and complying with relevant legislation.

The university has been awarded ISO 14001:2015 and ISO 45001:2018 accreditation for the last three years without any non-conformance or observation.

IGBC has mandatory requirements for energy efficiency, including ozone-depleting substances and minimum energy efficiency. Shiv Nadar IoE IGBC Gold Certification and meets all requirements.

Leadership in Energy and Environmental Design (LEED), requires measures to address carbon, energy, water, waste, transportation, materials, health, and indoor environmental quality. At Shiv Nadar IoE buildings are LEED certified.

Here we highlight some key initiatives:

1. The university buildings are IGBC[1] and LEED[2] certified, and measures have been taken to increase energy efficiency by installing,
   - solar power panels
   - energy-efficient lighting in new buildings
   - lean occupancy sensors in washrooms
   - review, analysis, and refurbishment of laboratories for the safety of operations and environmental conservation
   - carbon footprint computation and undertaking initiatives toward carbon emission neutrality
2. We continually review our energy use and identify opportunities for improvement to update our Energy consumption analysis and conservation plan. This helps in judicious energy usage and optimization through energy-efficient practices in campus operations.
3. We are committed to transitioning to green/ clean energy initiatives. To achieve this, strategic initiatives have been undertaken with support of university management to transition to 'clean power' and reduce the dependence on 'fossil fuel'.

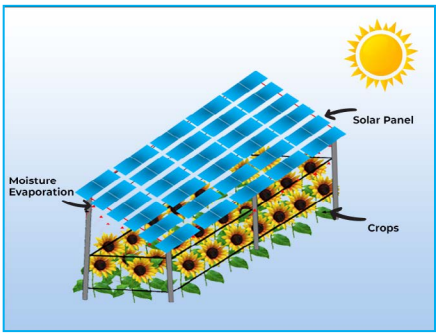
**For examples:**

- Solar water heaters are installed in selective hostels
- Solar power plant of a capacity of 430kwp have been installed to transition from complete captive power generation to solar power
- Transition 50% car fleet to electric vehicles. At present, the university has 60% CNG cars, 30% petrol cars, and 10% diesel cars. The plan is to transition to 50% of the fleet as electric vehicles
- Battery-operated urinal sensors have been converted to an electrical-operated sensors
- Motion sensors are installed in toilets in academic and hostel blocks

## 4 Partnerships

### Research and development of Agrivoltaics

The School of Mechanical Engineering has collaborated with Madan Mohan Malaviya University of Technology, Gorakhpur, to create a solution for the future needs of food and energy, such that both crops and electricity can be produced in a single land use system. Funded by the Council of Science and Technology, U.P. (CST, U.P.), the project is developing an agrivoltaic - photovoltaic array for power generation and crop cultivation. The significance of




agrivoltaic is that while one can farm and produce electricity on the same land, It also leads to benefits such as, water used during farming cools the solar panel, and increases its efficiency thus generating more electricity. At the same time, crops will require less water due to solar panels which will reduce radiative heat loss between the crop and the panel.

### High-performance supercapacitors through nano-moulding and surface activation

Dr. Harpreet Singh Arora, Professor and Head of Department of Mechanical Engineering, in collaboration with the Scientific and Useful Profound Research Advancement (SUPRA); and

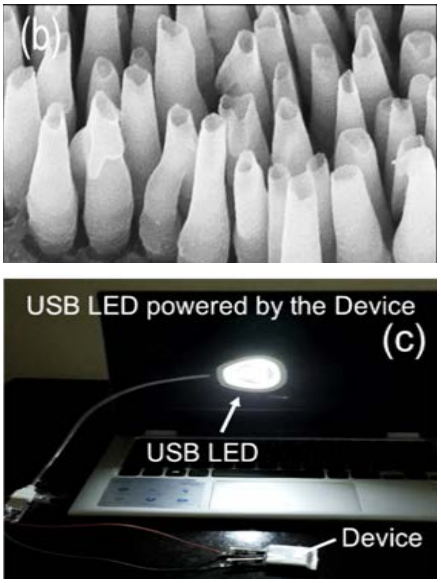



**Figure :** (b) Scanning electron microscope (SEM) images of the nano-tubes developed in NiMn alloy using a novel physical deformation approach; (c) Device fabricated using these electrodes is used to power the USB LED.

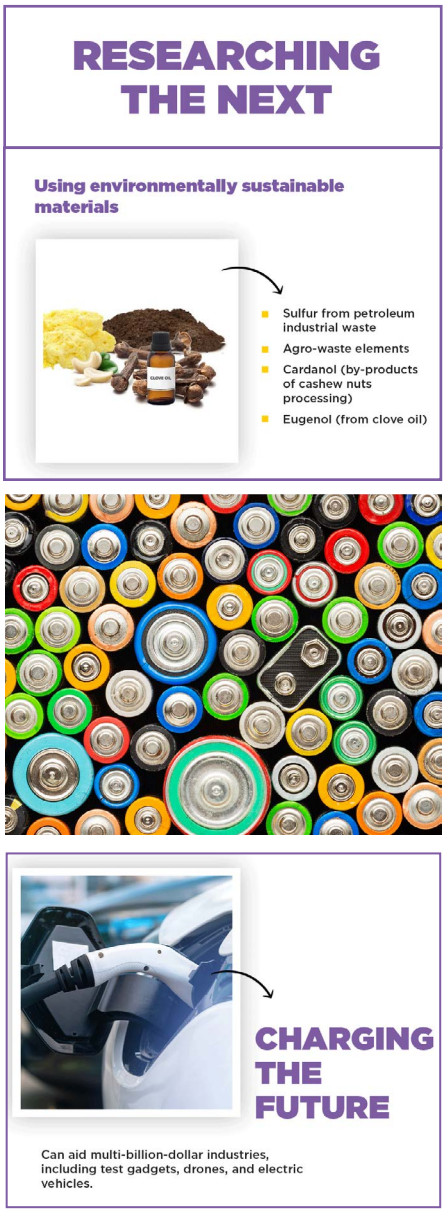
the Department of Science and Technology (DST), is developing a facile and highly efficient technique for generating chemically active nano-textured transition metal oxides with high compositional control. The proposed technique utilizes a short burst of localized physical deformation to facilitate the material flow into the nano-moulds at temperatures ~ 0.3 times the alloy melting point.

The project breaks the barriers of sub-homologous nano-moulding in crystalline materials.

The technique in the project opens new research directions and is poised to impact materials development for various applications, including hydrogen generation, bio-sensing, and electro-catalysis, besides standard structural components.

## Instititutions collaborate to develop new battery technology

Focused on the principles of green chemistry to find a solution that simultaneously addresses the need of the industries and the environment, Dr. Bimlesh Lochab, Professor and Head of the Department of Chemistry along with her team has collaborated with




Dr. Sagar Mitra at the Department of Energy Science and Engineering at the Indian Institute of Technology-Bombay to develop Lithium-Sulphur battery prototype. The study has the potential to aid multi-billion dollar industries, including tech gadgets, drones, electric vehicles (EV), and several more that depend on such batteries.

## Industrial collaboration - services for energy efficiency and waste management

The Department of Chemical Engineering has collaborated nationally and internationally on the issue of waste management and alternative use of clean energy relevant to Sustainable Development Goals 7, 12, and 13.

Assuming the responsibility to support the industry in finding a resolution to their perpetual problems while working to impact the Environment positively, the Department of Chemical Engineering established collaboration with nearby industries, such as Kawatra paper mills, Dadri, Kings International Ltd, Unnao (Leather industry), and nearby restaurants to help them not only find an eco-friendly and sustainable solution to the waste management but also to help convert the waste into energy.

Shiv Nadar Institution of Eminence is fully committed to the UN Sustainable Development Goals (SDGs). We have embraced a four-pronged strategy for SDGs through **teaching, research, our core institutional practices, and partnerships.**

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