PANDIT DEENDAYAL ENERGY UNIVERSITY

STRATEGIC PLAN 2021-25

1MW Solar Power Plant Intergrated to the Grid

The ground-mount photo-voltaic (PV) power plant is the first of its kind in Gujarat with Multiple Technologies available at one place. It was implemented in 106 days in 2011.

It has Solar Radiation Resource Assessment (SRRA) and Advanced Measurement Stations (AMS) supported by NIWE to carry out assessment and quantification of solar radiation, data processing, quality of data, modeling and to support the making of solar atlas of the country. It also has facility for collection and analysis of solar and meteorological data that is crucial for research and developmental activities.

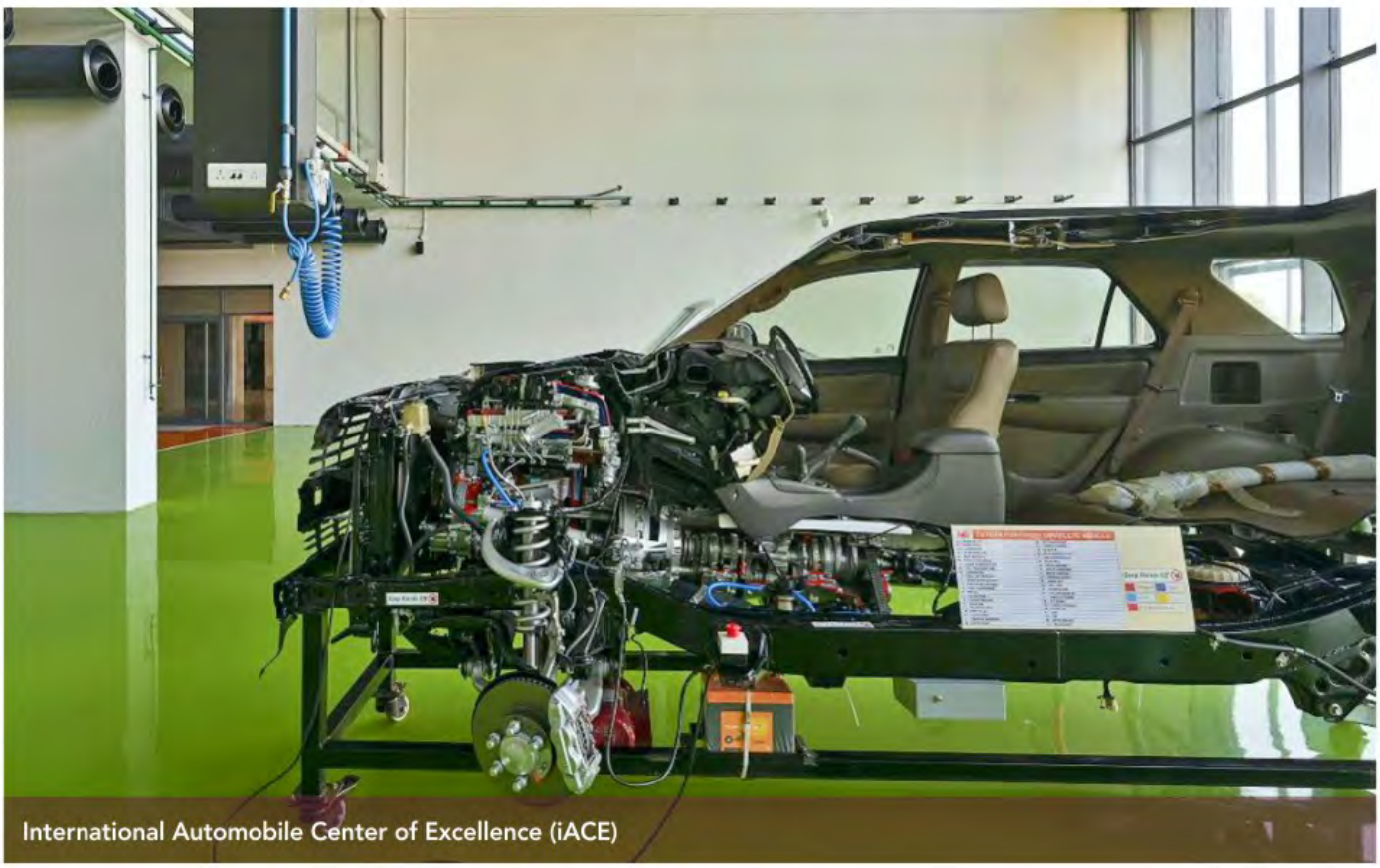
Vanadium Flow Battery for Energy Storage

Content

Centre of Excellence for Geothermal Energy (CEGE)

Drilling, Cementing & Stimulation (DCS) Research Centre

Siemens Automotive Centre of Excellence



International Automobile Center of Excellence (iACE)

Foreword

Pandit Deendayal Petroleum University (PDPU) was established with the mission of taking the technical education standard of this country to the next level. This saga is a celebration of discipline, pride, and joy in learning. Faculty enriched with expertise in their areas and Student Community with the intention towards transforming the society for a better tomorrow is the backbone for this family of values. Research in the campus stands as the finest jewel of its achievements in the past decade and the pace of this achievement is a proven history. The creation of the brand "PDPU" is the consistent effort of countless inspiring individuals for the last 13 years. Our institution is repositioning itself to a new focus to address the demands and challenges of the millennial generation with a 2020-25 plan.

Our institution has grown leaps and bounds in strength and stature in the last decade. The institution is relatively a young University deserving to be a beacon for the future generation's empowerment. We are able to witness the fruit of our labor in seeing alumni visiting us. Over the years the confidence of the parents and stakeholders have increased to a significant level evident by rising enrollment in admissions, reciprocation from the Alumni in technical and placement front, increasing collaboration from both public and private sectorcompanies, and generous funding from the Government agencies. Key Government agencies, MNC companies, and NGO's have recognized the institution's relevance in skill-based training, the performance of and ethicalconduct of the Alumni, giving us an attestation of achieving the graduate attributes. Today, our Institution is recognized as the nodal center for various, teaching, research, and innovative initiatives.

Teaching across the campus is witnessed as a routine but outstanding exercise adhering strictly to the academic calendar. The success rate for our teaching practice has remained very high due to dynamic course corrections brought from time to time through the industry connect. The various accreditation agencies have given their annual feedback to revitalize the teaching-learning process to be at its best. Today our institution is tested and tried in all formats of accreditation including the most important National ranking Framework conducted by our Federal Government which has placed our institution in the top 100 among 1200 odd institutions in the 2016 NIRF ranking. Our campus strives hard to compete with the best institutes in India, by disseminating knowledge through social and electronic media.

Employer engagement in the curriculum has also increased significantly with an innovative mentoring, internship, and academic proficiency awards instituted in the employer's name. The institution is passionately aware of its social connection to the local community. In the vicinity of the institution is adopted to increase their technical infrastructure and to bring awareness program on higher education. It is gratifying to note that the influenced community comes back to us for pursuing higher education.

There are several physical manifestations of our growth in capacity building in the last five years. This includes housing three Centers of excellence and a Technology Business Incubator. New infrastructure for co-curricular and extracurricular activities have increased the synergy of our holistic education. Financially the institution has struck a balance to realize good stability in the last five years. We are positioning ourselves to invest in new verticals both in research as well as new academic programs.

While we are conscious of our growth and justifiably proud of our progress, there is a great quest for us to transcend and transform to the demand of the industrial and social

revolution. There are more to be done to engage the great number of learners in STEM (Science, Technology, Engineering and Mathematics) related programs as the skill sector is rapidly looking for changes with relevance to Industry version 4.0. This gives a massive opportunity for the institution to keep abreast with the changes and demands that the Industry is looking for. The institution plays a key role to understand the changing mindset of the millennial generation and has introduced programs on Liberal Arts, Humanities and basic sciences apart from the professional courses to aid the social demands.

The Institution is currently planning and proposing to bring structural changes apart from the academic programs to make this institution an Institute of Eminence (IoE) in learning. We will be prime movers in recognizing and unlocking the talents and preparing individuals to reach their full potential in the next five years (2020-2025)

Professor S. Sundar Manoharan
Director General
Pandit Deendayal Energy University

Our VISION and MISSION

"PDPU will continue to make its unique contribution to enhancing the reputation of Gujarat and India in energy education and research."

Dr. Mukesh D. Ambani,
President and Chairman
BoG, PDEU

The Institution pursued its vision and mission with a single minded devotion. We envisioned to be and efficient and competent source of technical manpower for the current and future industrial requirements. To that end our mission is three-fold; Undertaking education in energy engineering and management, nurture students of extraordinary motivation for lifelong learning, and establishing an institution of excellence in Energy Education and competitive edge in research.

It is gratifying to place on record that we have achieved this Vision with great resolve and purpose. We have not only stayed relevant in technical education but also being seen as a significant source of Manpower for industrial needs. Most of the companies have tagged our institution alongside other MHRD aided institutes of higher learning in offering premium placements. Our students have established a "Niche in the Industry". Mentoring has been the buzz word of our entire teaching process. Our faculty have owned the Vision and Mission to mentor the students to give a holistic perspective and to establish a vital cord of accountability with the Society.

As an Institution, Our Vision for the future is, to be recognized as a valued knowledge partner and a technology mentor both regionally, nationally and Internationally. We will consistently make a difference in the lives of young learners, raising them as effective citizens who will influence their sphere of Society where they serve. True to the expectation of our stakeholders, we have effected major changes in the curriculum for the next five years with reference to Industry 4.0 & Business 4.0. To effect this change, new research facilities will be added, major funding initiatives will be sought from the funding agency, technical manpower will be imbibed with professional and higher skill-based training. On the whole, we will embark into a translational research-oriented campus for a transformational change in society. To this end, "PDPU" will be the choice destination for Young and Adult learners and employers.

"I am glad to see PDPU is creating its own identity, not just in the country but also in the world. And I am very proud to see that this university is far ahead of its time. In the last one-and-a-half decades, the PDPU has expanded in many spheres, including the energy spectrum, besides the petroleum sector. Given the progress of PDPU today, I would request the Gujarat Government to rename it from Petroleum University to Energy University by amending laws".

Hon'ble Prime Minister of India Shri Narendra Modi
(8th Convocation of Pandit Deendayal Petroleum University)

A GLIMPSE OF THE INITIATIVES TAKEN DURING 2015-2020

The institute positioned itself to launch several initiatives to bring visibility in academics, research and Faculty empowerment. Setting our eye on the completion of 10 years around the corner (year 2016), Accreditation, Ranking and capacity building were the foremost priority in the list of important initiatives envisaged.

1. Accreditation:

Our institution will prepare itself to appear for the NAAC accreditation, first cycle by 2016. University To this end all the academic course revisions will be done, research publications and project funding will be accessed and monitored to give the thrust needed for the exercise. PDPU will also apply for the U/S 2 (f) status and for SIRO, GOI recognition to enhance the research focus. PDPU has been assessed and accredited with an 'A' grade and CGPA of 3.39/4.0 by NAAC in the year 2016.

2. Centers of Excellence:

The university is well-recognized by ISO, AICTE & UGC to impart quality education and training. PDPU has various centers of excellence to establish cutting-edge research: Siemens Centre of Excellence, Centre of Excellence in Geothermal Energy (CEGE), Solar Research and Development Centre, Centre for Biofuel and Bioenergy Studies.

2. a School of Petroleum Technology (SPT)

PDPU had established a center for Drilling, Cementing and Stimulation Research Centre (DCS) to conduct excellent, high -tech, and cutting-edge research by providing state-of-the-art research facilities. The center has received a fund of 10 crores from the Government of Gujarat.

2. b An International Automobile Center of Excellence

With an MoU signed between PDPU, Maruti Suzuki India Limited and the generous support from the Government of Gujarat (GoG) PDPU has set up a state of the art Center of Excellence in Automobile to give hands-on experience for students to understand the product & testing line so that the stakeholder is ready for adaptation to the Auto Industry. This is an initiative that has resulted from the MoU signed during the Vibrant Gujarat Summit 2013 between PDPU, GoG, and Maruti. Through this facility 17 certificates, PG programs will be launched. In the areas of automotive manufacturing and automotive electronics. These courses will be offered by trained faculty from PDPU.

2. c Innovation and Incubation Centre

The Institute have been in the practice of working towards patent and product development. To facilitate the process and to encourage technology Incubation, it is desired to house an IIC in collaboration with DST, MSME, TiE, IPPO to build an exclusive Incubation facility. Intellectual Property facilitation cell (IPR) having seen a cascade of innovations sprouting from the students and faculty research initiative, an IPR Apex committee will be installed under the banner of the IIC. committee will be installed under the banner of the IIC.

3. Capacity Building:

3. a Academic/ Research Block for Capacity building

Measures are currently underway to contextually reassert ourselves to the new technological demands. In view of that, we have developed a 40 cr facility dedicated for the center of excellence in clean energy, clean water, carbon capture, sustainable production and consumption of energy, electric vehicles, machine learning and AI – based robotics. This six floor facility will house laboratories engaged in translational research involving 9 verticals of Industry 4.0 namely; Augmented and Virtual Reality, Additive Manufacturing, Artificial Intelligence, Industrial IoT, Big Data, Cyber Physical Systems, Cyber Security, Data Science and Nanotechnology.

3. b Starting new Engineering Courses

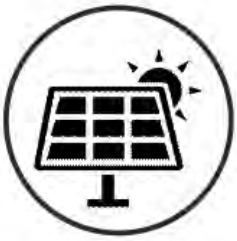
Courses In addition to the existing engineering programs available at the School of Technology, of four new departments and corresponding B.Tech programs in Computer Science and Engineering, Information and Communication Technology, Electronics and Communication Engg (ECE), and Automobile Engineering are envisaged. New M.Tech programs in the Faculty of Engineering and Technology will be initiated, namely;

- Mechanical Engineering (Manufacturing Technology)
- Civil Engineering (Transportation Engineering)
- Petroleum Technology (Exploration)
- Data Science
- Cyber Security
- Energy and Environmental Management
- Material Science and Engineering

3. c High Rise Hostel

High Rise Hostel PDPU has created a very good quality hostel infrastructure for undergraduate students. However, there is a need to develop high-rise hostel facilities for scalability and international students. This will facilitate the global student community on campus.

4. Manufacturing Process line for Solar Photovoltaic panel:



Having received substantial funding from Gujarat Energy Development Authority (GEDA), PDPU will strive to establish a manufacturing process line for fabricating Silicon Solar Photovoltaic Panel. This Manufacturing process would cater to the demand especially to transform villages and sub-urban areas to become self-reliant in energy requirements and also to subscribe to "Atma Nirbhar Bharat".

5. Sports Complex:

The University has developed a sports complex to develop the power of endurance, discipline, and teamwork with the support of the Sports Authority of Gujarat under Urban Infrastructure, spread over 15 acres. This facility will also be available for various and state and national players without any cost for their overall development.

6. Chair Professorship:

Seeking Institutional support from the Government, Public Sector, and Private Industries for the development of the University, especially for setting up Chair Professors will be undertaken. PDPU has initiated to further the cause of Academic and Research Excellence at the University. PDPU along with Shell Hazira LNG Private Limited, Suzlon Energy Limited has agreed to workout Chair Professorship in the related domains.

7. Study in India Program:

To complement the Process of Internationalization, PDPU has introduced the Study in India Program to host international Faculty and Students on campus for studying and discovering Indian Society, culture, politics, Socio-Economic scenarios, and the world affairs.

8. Globalization Efforts :

To undertake this vision of the University for its students, the University has collaborated with various reputed universities across the globe. It intends to develop an intellectual knowledge resource with leadership skills to compete in the global arena. The collaborations enable the University to provide international exposure to students by developing joint research projects as well as long-term and short-term courses at these reputed universities.

1. PDPU sends students abroad for:
   - International Exposure Program
   - Semester Study Abroad Program
   - Summer Research Internship
2. International Students at Campus
3. Travel Grant Policy Support
4. International Admission in International universities
5. Admitting International Students through Direct Admission of Students Abroad - DASA (DASA is Scheme of Ministry of Human Resources Department, Govt. of India)
6. Study in India program for International Students
7. AIESEC student group for incoming and outbound International program

MONITORING MECHANISM FOR THE STRATEGIC PLAN

BOARD OF GOVERNORS	
Dr. Mukesh Ambani Chairman & MD Reliance Industries Ltd. & President Pandit Deendayal Energy University Chairman of the Board	**Shri D. Rajagopalan,** IAS Former Chief Secretary – GoG, Chairman - Standing Committee Pandit Deendayal Energy University
Dr. R. A. Mashelkar FRS Bhatnagar Fellow & President-Global Research Alliance National Chemical Laboratory – Pune	**Dr. S. Sundar Manoharan** Director General Pandit Deendayal Energy University
Shri Sudhir Mehta Chairman, Torrent Group Ahmedabad	**Shri Shashi Shanker** Chairman & Managing Director Oil and Natural Gas Corporation (ONGC)
Smt. Anju Sharma, IAS (Ex officio) The Secretary to Government In-charge of Technical Education Government of Gujarat	**Smt. Sunaina Tomar,** IAS (Ex officio) The Secretary to Government Energy and Petrochemicals Department Government of Gujarat
Mrs. Pallavi Shroff Shardul Amarchand Mangaldas & Co. New Delhi	**Shri Jalaj Dani** Chairman – IIM - Trichy and Co-promoter of Asian Paints
Shri Parimal Nathwani Reliance Industries Ltd	**Dr. Nigam Dave** Dean Faculty of Liberal Studies Pandit Deendayal Energy University Nominee of Gujarat Energy Research & Management Institute - GERMI
Dr. Sunil Khanna Director School of Technology Pandit Deendayal Energy University	

MONITORING MECHANISM FOR THE STRATEGIC PLAN

STANDING COMMITTEE
Shri D. Rajagopalan, IAS Former Chief Secretary – GoG, Chairman - Standing Committee Pandit Deendayal Energy University
Dr. S. Sundar Manoharan Director General, Pandit Deendayal Energy University
Shri Sudhir Mehta Chairman, Torrent Group Ahmedabad
Mr. Nitin Shukla MD & CEO, Hazira LNG Pvt. Ltd. Ahmedabad
Mr. Palak Sheth Director- Planning & Development Pandit Deendayal Energy University

FINANCE COMMITTEE
Chairman **Dr. S. Sundar Manoharan** Director General Pandit Deendayal Energy University
Mr. Nitin Shukla MD & CEO, Hazira LNG Pvt. Ltd. Ahmedabad
Director - School of Petroleum Technology Pandit Deendayal Energy University
Registrar Pandit Deendayal Energy University
Chief Finance Officer - (Invitee) Pandit Deendayal Energy University

RESEARCH ADVISORY COUNCIL	
CHAIRMAN **Dr. R. A Mashelkar, FRS** Member, Board of Governors, PDEU President - Global Research Alliance Former Director General, CSIR & Secretary, DSIR, Govt. of India	**Prof. T Pradeep** Deepak Parekh Institute Chair Professor Department of Chemistry Indian Institute of Technology, Madras
Prof. Prabuddha Ganguli CEO, Vision-IPR and Visiting Professor, Rajiv Gandhi School of IPR, IIT Kharagpur and International Consultant, World Intellectual Property Organization	**Dr. Ashish Lele** Senior Vice President and Head Advance Material and Alternative Energy Group Reliance Industries Ltd
Dr. Dinesh Srivastava Chairman & Chief Executive Nuclear Fuel Complex, Hyderabad Dept. of Atomic Energy (DAE), Govt. of India	**Prof. S. K. Ghosh** Head, Food Technology Division, BARC and Distinguished Professor, University of Mumbai

MONITORING MECHANISM FOR THE STRATEGIC PLAN FOR 2015-20

1. **Accreditation:**
   To initiate the Accreditation process, a coordination committee will be step up with the Director General as the Head and the SSR preparation will be monitored and appraised.

2. **Capacity:**
   The Registrar's office will oversee the construction and installation of the Centers of Excellence. In close coordination with Chief Campus Manager and Team.

3. **DST / TBI:**
   Director General will liaison with GoG and DST to set up the Innovation and Incubation cell.
   Necessary approvals will be sought from the funding agency.

4. **SRDC:**
   Solar Research Development Centre will coordinate the utilization of the data from 1 MW solar plant and propose the sketch for the design and installation of assembly/product line for monocrystalline solar cell.

5. **IPR:**
   An IPR Apex Committee will be formed to oversee the IPR activity and also to identify a regular attorney for streamlining the IPR filing process.

6. **Academic Council:**
   The Academic Council maintenance academic standards within the University, and the planning, coordination, development, oversight, validation, and review of the curriculum and all academic work of the University and advising the Governing Body.

7. **IQAC**
   Inernal Quality Assurance Cell to develop a system for conscious, consistent and catalytic action to improve the academic and administrative performance of the University. To coordinate the dissemination of information on various quality parameters of higher education also to coordinate the quality-related activities of the institution.

MAJOR OUTCOMES OF THE STRATEGY PLAN FOR YEAR 2015-2020

1. International Automobile Center of Excellence (iACE)

iACE developed by Maruti Suzuki (I) Ltd. In association with the Government of Gujarat and PDPU as knowledge partner is a world class facility spread over 9600 mtr. sqr.

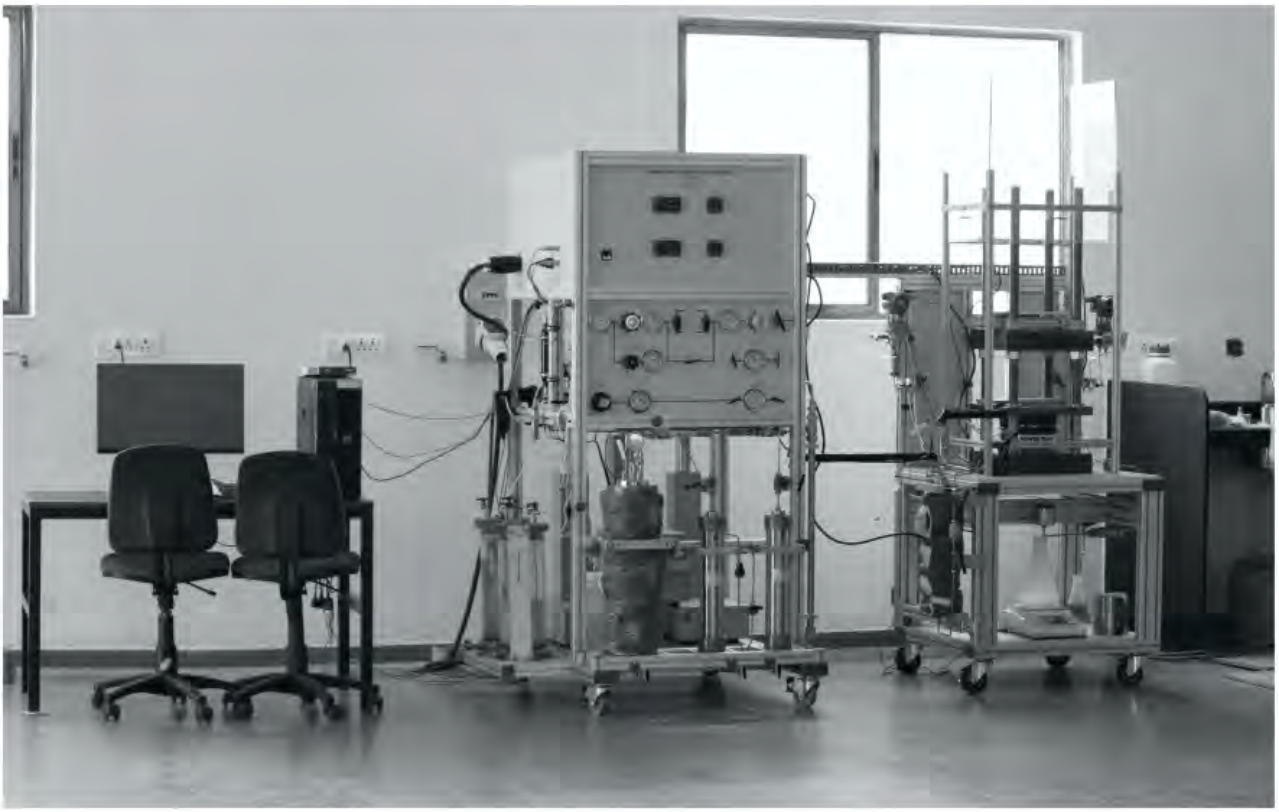
Collaboration: Provides end to end training and development in automotive manufacturing and automotive systems. The centre is a world class institute catering to end to end training, development needs of the automobile ecosystem. iACE will host the latest state of the art infrastructure and technology to deliver experiential learning to trainees. The institute will draw upon the expertise of industry-academia collaborations with Indian and Foreign players to ensure industry relevance of learning interventions.

Outcome:
Our Mechanical & Electrical Engineering Faculty Members (Around 15) have been trained to offer PG and Certificate Programs. This can lead to consultancy services. Students' project Quality will improve because of this infrastructure. Faculty can get funded projects citing the infrastructure available at PDPU More collaborations, internships, and placement from Maruti manufacturing.

International Automobile Centre of Excellence

2. Drilling Cementing and Stimulation (DCS) Research Center

DCS Research Center is established under the aegis of Government of Gujarat State Petroleum Corporation (GSPC). **It is in alignment with the "Make in India"** vision of our Honorable Prime Minister Shri Narendra Modi. It is utilized for the purpose of research, training and consultancy. It is also helps the government of India in formulating various policies pertaining to the upstream to the petroleum Industry. The cetre has undertaken a consultancy worth ₹1 Crore in terms of ER screening and has conducted proppant testing amount to 3 lakhs. The research center also has several cutting edge research projects in production enhancement.



3. Manufacturing Line for Mono Crystalline Solar Cell

This production line will demonstrate the process of cell to panel integration, lamination and EL testing. This will be the first demonstration of manufacturing capability for 45MW SPV modules through the Academia-Government partnership. The manufacturing line will enhance skill-based training, industry-ready experience, experiential learning and create job opportunities for learners trained under vocational schemes.

4. INDO-EU BILATERAL PROJECT UNDER HORIZON 2020 "INDIA-H2O" For Industrial Waste & Desalination

The overall aim of India-H2O is to develop, design and demonstrate high-recovery, low-cost water treatment systems for saline groundwater and for domestic and industrial wastewaters. Pilot small-scale (5k to 50k litre/day) rurally-relevant low-cost systems for brackish groundwater treatment to provide safe drinking water at costs below 30 Rupees for 1000 litres.

5. Accreditation:

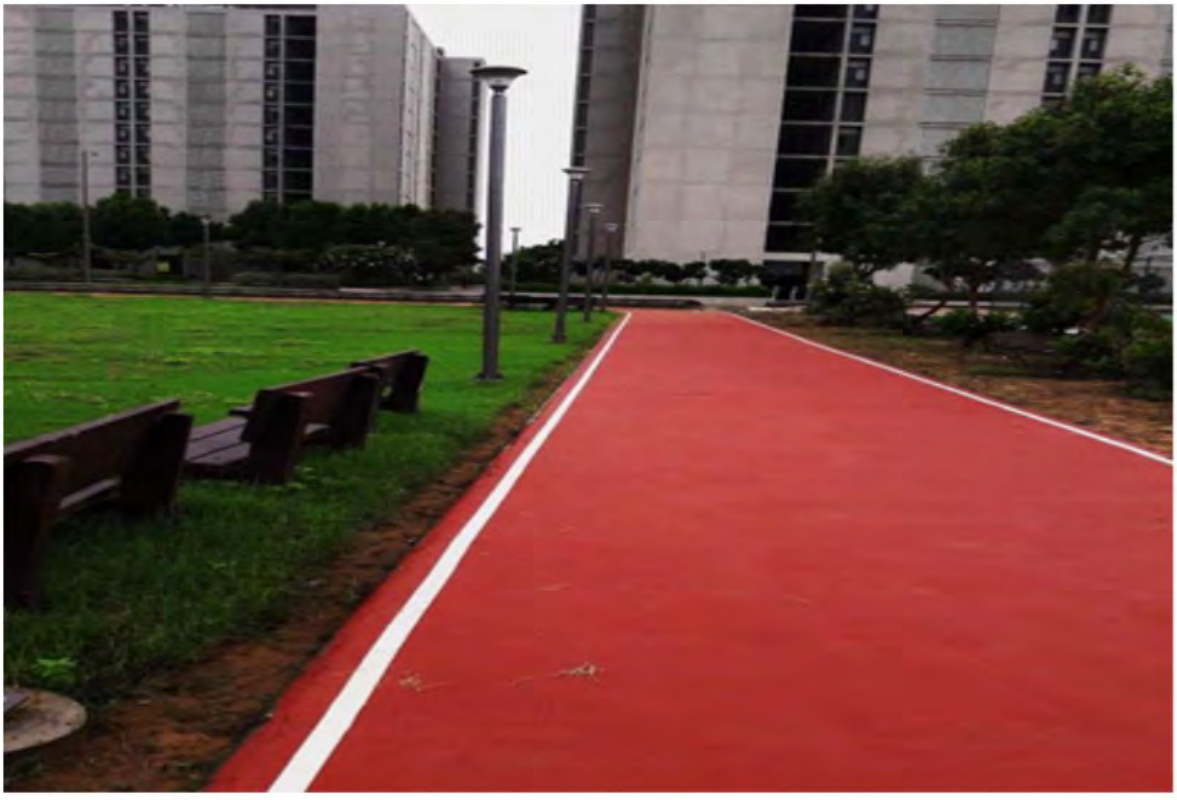
Our NAAC first cycle accreditation was successfully carried out. PDPU has been awarded an "A" (A+ on a new scale) grade with a CGPA of 3.39/4.0, in the year 2016. The mechanical engineering department has been awarded Tier-1 NBA Accreditation for 3 years in October 2019.

6. IPR Cell actively pursuing product/ process and design patents. More than 13 patents were filed and granted.

7. Sports Complex

A synthetic 400 mtr track was developed adjacent to the hostel to enhance more extracurricular activities for the Hostel Students. Further 3 gymnasia in a hostel and 3 gyms in the academic area to encourage student fitness.

Synthetic Track and Basketball Court at the Hostel Premises



STRATEGY PLAN FOR THE YEAR 2020-25

1. TRANSFORMATION EDUCATION:

It is focused on developing an intentional, aligned and integrated culture that radiates the beliefs, values and life skills in order for the youth to be successful. Transformation Education works because it harnesses an organization's systems, staff, environment and curriculum to provide an enriched and effective milieu for educating the aspiring youth.

Industry 4.0 is the digital transformation of industrial markets (industrial transformation) with smart manufacturing currently on the forefront. Industry 4.0 represents the so-called fourth industrial revolution in discrete and process manufacturing, logistics and supply chain (Logistics 4.0), the chemical industry, energy (Energy 4.0), transportation, utilities, oil and gas, mining and metals and other segments, including resources industries, healthcare, pharma and even smart cities.

Industry 4.0 is the evolution of cyber-physical systems, representing the fourth industrial revolution on the road to an end- to-end value chain with Industrial IoT and decentralized intelligence in manufacturing, production, logistics and the industry.

Originally Industry 4.0 was conceived in the context of manufacturing, yet this has changed. So, while all these industries fall under the scope of Industry 4.0 and are tackled in the academic, governmental and industrial collaborations which led to 'Industry 4.0'. While it still remains early to speculate on employment conditions with the adoption of Industry 4.0 globally, it is safe to say that skilled workers will be need to acquire a different or an all-new set of skills.

Our entire curriculum and skill-based training will aim to adopt to this digital transformation and will empower the students with experiential learning.

Specific Initiatives:

1. **Skill Training and Skill Based Courses:** In the next five-year plan, Skill development (training from centers of excellence) will benefit through number of certification courses and programme. Certification programmes in modern analytical methods, production and manufacturing skills will be initiated through apprenticeship programmes for industry demanding skill opportunities. We will further encourage technology business commercialization programme for the skill trained learners to plunge into the entrepreneurship world.

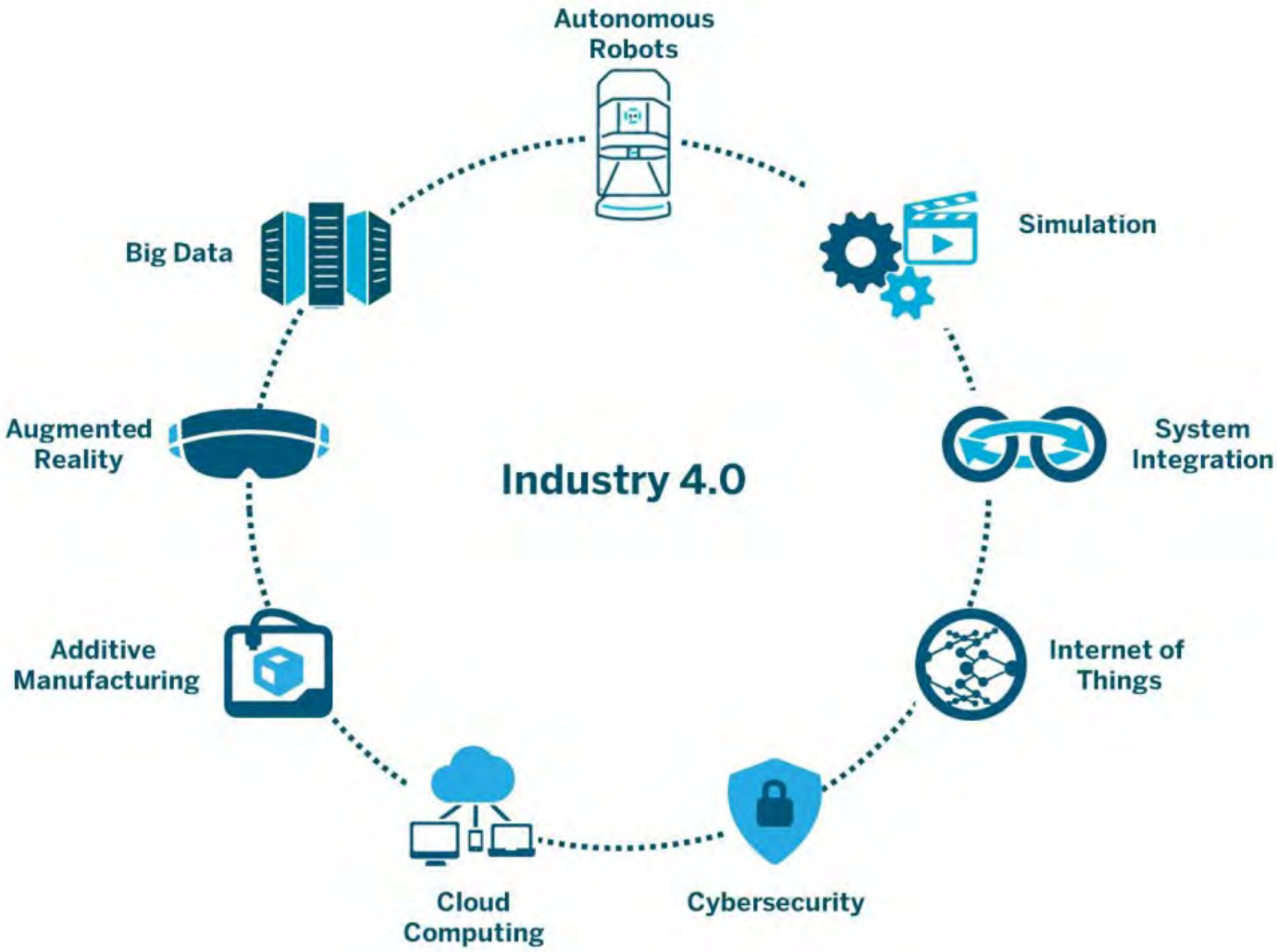
2. **Swayam Courses :** The institute is already a distinguished platform for initiating courses offered by Swayam/MOOC and Coursera platform. Knowledge dissemination is exponentially growing as a result of our engagement. IN the next five years we hope to see a minimum of 40% of students credit extra courses from the Swayam/ Coursera platform. Our campus will witness a flagship initiative for MOOC courses. We will also strive to become part of the resource group for the Swayam courses.

3. **International Semester Abroad/ Exchange Program:** The Office of the International Relations (OIR) will strive to establish a steady flow of outbound and inbound students to engage in exchange programs so as to maximize the learning options and to have a Global perspective in the credited courses. This can be viewed as a major input for inter-disciplinary learning practices along with industry exposure and endorsement.

4. **Accreditation and Ranking:** Having launched all major initiatives in redressing the teaching learning process and teaching-learning resources, we look forward to empowering ourselves with all approvals mandatory and optional to place ourselves as a leading institute in the national and international formats. As a first initiative, we have already established ourselves as in the NIRF ranking. We desire to be on par with MHRD funded technical institutes nationally and among Top 500 Universities, Globally. This is our quest and we will press towards this milestone by engaging in NBA, GSIRF ranking, and Accreditation Process.

5. **Curriculum I-4.0:** In our pursuit to equip our students with Industry readiness, the entire course curriculum is revised to Industry 4.0 demands with more than 40% credits allotted to experiential learning and with patterned outcome-based education. This mammoth activity was undertaken by our dedicated faculty in active collaboration with the Industry. Over 10% of every course at the University is taught by industry professionals and eminent adjunct faculty. The key features of the new curriculum include Mixed/Augmented/Virtual reality, Industry IoT, Cyber Physical system, Artificial intelligence, Block-chain technology, and Machine learning. "Next Generation Laboratory" a new initiative taken by our Institution will empower the students in Virtual and Augmented Reality, AI, and IoT, and in Block Chain.

Industry 4.0 is the digital transformation of manufacturing, leveraging third platform technologies, such as Big Data/Analytics and innovation accelerators, such as the (Industrial) Internet of Things, and enabling the convergence of IT (Information Technology), OT (Operational Technology), robotics, data and manufacturing processes to realize connected factories, smart decentralized manufacturing and the digital supply chain in the information-driven cyber-physical environment of the fourth industrial revolution.



Proposed Sports Complex :

Extra-curricular and co- curricular programs are an integral part of the curriculum.
PDPU has always been inclined to have a state-of-art sports facility at the campus to give equal emphasis to the physical, mental, and moral development of students.

The Sports Authority of Gujarat (SAG), GoG had announced a scheme to provide financial assistance for setting-up Urban Sports Infrastructure. To identify students with outstanding abilities and place them in an environment designed to produce sporting and educational excellence, To encourage students to maintain their academic interest using sport as the means of engaging them to achieve the best they can be and to provide lifelong learning experiences through teamwork, discipline, and cooperation.

Proposed Central Library :

In keeping with the vision and mission of the University, PDPU has proposed to promote knowledge generation and application through its effective dissemination. The library, therefore, acts as the main learning resource Centre of the University and provides services and facilities to meet the requirements of the University's teaching, training, and research programmers.

The enhanced central library is aimed to support the learning process of the PhD/PG/UG students through the provision of knowledge/information, meet the knowledge/information needs of the faculty, to support their teaching activities. The Central Library will provide 9875Sq mtr facility to house digital library, enhanced seating facility, and reference book session, exclusive periodic journals, discussion cubical for current literature survey and a great platform for clinical thinking and cognitive development.

2.TRANSLATIONAL RESEARCH

Aiming to be recognized as a I4.0 Campus, some of the verticals we wish to pursue include:

1) Additive Manufacturing (AM) & Industry 4.0 is the recent move into intelligent technology automation. In this new era, the use of modern skills of Additive Manufacturing within the context of information technology integration plays an important role in industrial economic competitiveness. As can be seen, there's no doubt that 3DP technologies are leading to the next major industrial revolution. Due to its versatility, Additive Manufacturing plays a key role in Industry 4.0, saving time and costs, being decisive for process efficiency, and reducing its complexity, allowing for rapid prototyping and highly decentralized production processes. Currently, more and more industrial segments are adopting AM. The smart factories of the future have all processes interconnected by the Internet of Things, incorporating greater flexibility and individualization of manufacturing processes is an appropriate name to describe the technologies that build 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal, concrete or one day.....human tissue. Common to AM technologies is the use of a computer, 3D modeling software (Computer-Aided Design or CAD), machine equipment, and layering material. Once a CAD sketch is produced, the AM equipment reads in data from the CAD file and lays down or adds successive layers of liquid, powder, sheet material, or other, in a layer-upon-layer fashion to fabricate a 3D object.

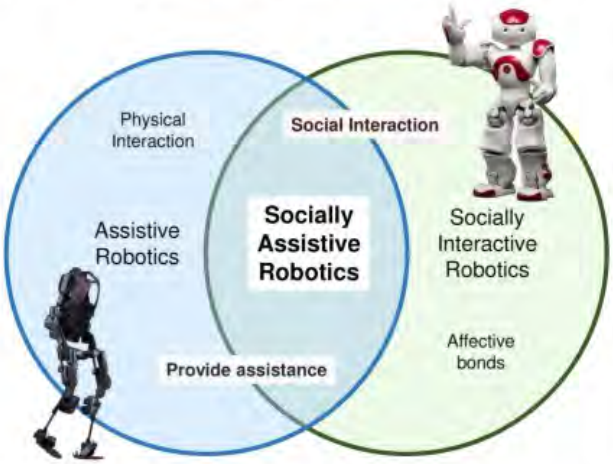
The term AM encompasses many technologies including subsets like 3D Printing, Rapid Prototyping (RP), Direct Digital Manufacturing (DDM), layered manufacturing, and additive fabrication.AM application is limitless. Early use of AM in the form of Rapid Prototyping focused on preproduction visualization models. More recently, AM is being used to fabricate end-use products in aircraft, dental restorations, medical implants, automobiles, and even fashion products.

Intech Additive Solutions – a pioneer in additive manufacturing services since 2012 is recognized by 'Wohler Report-2015' as one of the first service providers of 3D Metal printing in India. With over three decades of rich experience in metallurgy and component machining backed by a strong team of diversified professionals in Design, Software, Analysis, Machining & Quality control, it provides end to end services in AM. With rich expertise in providing complex solutions for 3D Printing of Aerospace, Automotive, General Engineering, Medical, and Tool & Die parts, Intech Additive Solutions produced India's first Metal 3D printed Micro Jet Engine 'MJE20' in 2017. Intech Additive Solutions' IFusion SFI is India's first indigenously designed and developed Metal 3D Printer integrated with inhouse developed Build 'Build process software – AMBuilder' & 'AMOptomet – parameter optimizing software.' It is expected that collaboration with Intech will facilitate PDPU for the development of additive manufacturing with indigenous technology at low cost.

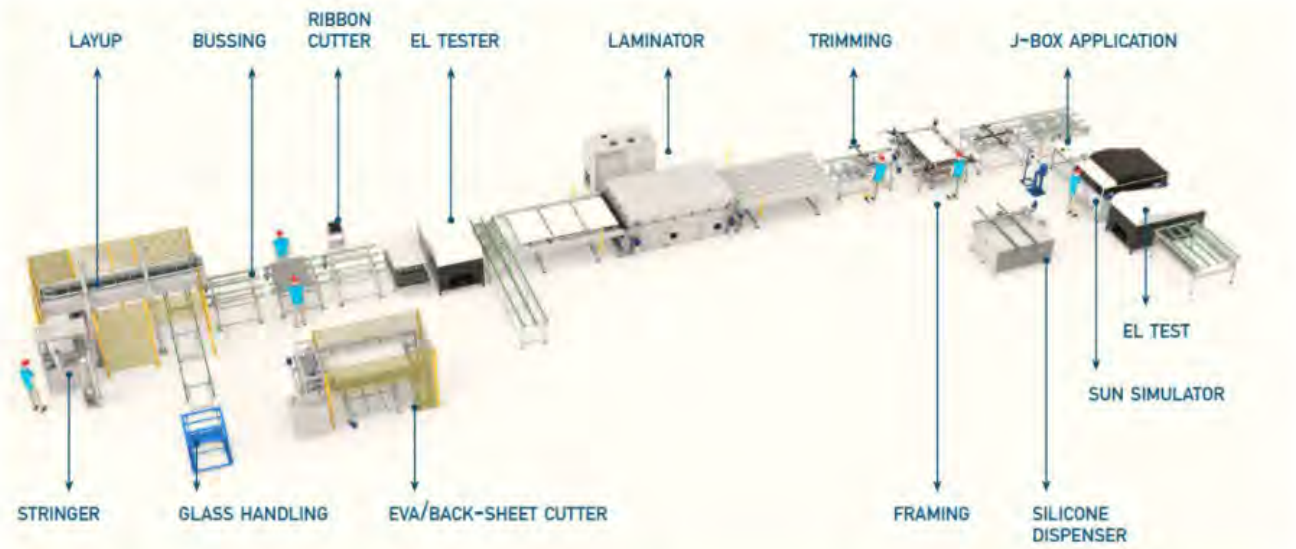
2) Cyber-Physical Systems: Industry 4.0 is the recent move into intelligent technology automation. In this new era, the use of modern skills of Additive Manufacturing within the context of information technology integration plays an important role in industrial economic competitiveness. This short review provides a basic understanding of the role of 3DP technology in Industry 4.0. As can be seen, there's no doubt that 3DP technologies are leading to the next major industrial revolution. Due to its versatility, the Additive Manufacturing plays a key role in Industry 4.0, saving time and costs, being decisive for process efficiency and reducing its complexity, allowing for rapid prototyping and highly decentralized production processes. Currently, more and more industrial segments are adopting AM. The smart factories of the future have all processes interconnected by the Internet of Things, incorporating greater flexibility and individualization of manufacturing processes.

3) Big-Data-Driven Quality Control: In engineering terms, quality control aims at reducing the inevitable variation between products. Quality Control depends to a large extent on statistical methods to show whether a specific feature of a product (such as size or weight) is changing in a way that can be considered a pattern. Ofcourse, such a process depends largely on collecting real-time or historical data regarding the product.

4) Robot-Assisted Production: The entire basis of the new industry relies of the smart devices being able to interact with the surrounding environment. This means smart devices equipped with cameras, sensors, and actuators that are able to identify the product and then deliver the necessary changes for it. Consequently, "robot coordinators" will become an active component of Production.

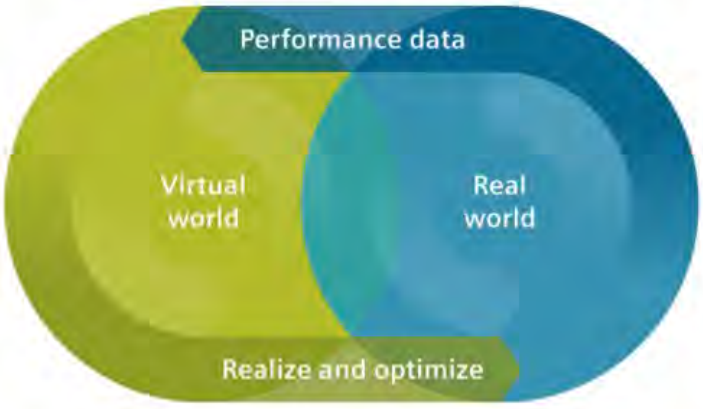


5) Product Line Simulation and setting up of manufacturing line: While the need for optimization for transportation declines, the need for industrial engineers (who typically work on optimization and simulation) to simulate production lines will increase. Having the technology to simulate production lines before establishment will open up jobs for mechanical engineers specializing in the industrial field. As a first demonstration, a manufacturing process line for 45 MW Single Crystalline Silicon Solar photovoltaic panel will be installed. As a first demonstration, a manufacturing process line for 45 MW Single crystalline Silicon Solar Power will be installed.



6) I 4.0 in Healthcare: In the world of medical device manufacturing, which is burdened with regulatory compliance and is still largely dependent on paper-based processes, what does Industry 4.0 really mean? How will it help manufacturers meet the demand for increasingly sophisticated, higher quality and rigorously regulated medical devices, and beyond that highly personalised custom devices? New trends in how medical devices are made and how they deliver value is fundamentally changing, devices are moving more and more into the world of the Internet of Things, utilizing highly sophisticated chipsets, processing capabilities and sensors. They are mobile and connected like never before, delivering solutions in innovative new areas such as patient-specific devices and 'Lab on a Chip' electronic diagnostic testing. Mobile devices that can track chronic and lifestyle associated diseases such as diabetes is a fast growing market area and one which response to the connectivity delivered by the IoT. Device examples include contact lenses that can detect glucose levels and devices to monitor calorific intake. A new area of bio-electronic medicine is also emerging, facilitated by the miniaturization of electronics. Here miniaturized devices are implanted in the body may help treat illnesses such as arthritis, diabetes and asthma by influencing electric signals in nerve pathways.

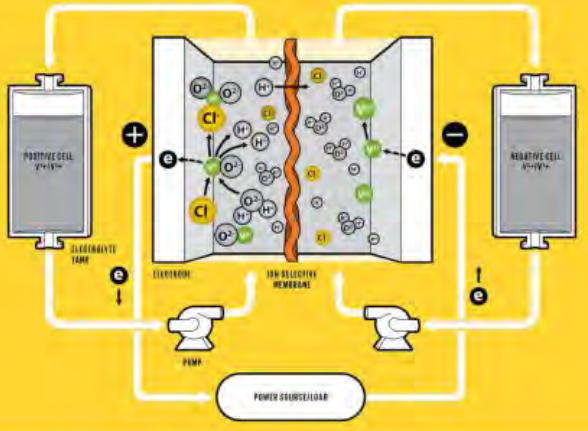
7) Next Generation Laboratory: Merging the virtual and the real world. Employing Virtual reality, Augmented Reality, Mixed Reality and Automation Developing a new product, planning a new plant, or producing with the help of digital tools creates a detailed virtual image, the digital twin. The digital twin creates new insights, thanks to the combination of physics-based simulations with data analytics in a fully virtual environment. This makes it possible to realize innovations faster and more reliable, while also requiring significantly fewer real prototypes. Even more, data are created when the product is being produced or a plant begins operation. These performance data of the real production and of the real product can be collected, analyzed and fed back into development. Here they help to improve and optimize new products and processes at an early stage.



8) Energy Storage : Redox Flow Battery for Future Energy Storage: RFB is an electrochemical energy storage device that converts chemical energy into electrical energy through reversible oxidation and reduction of working fluids. Through storing energy in recirculating liquid electrolytes, redox flow batteries have merits of decoupled energy density (tank size, electrolyte concentration, cell voltage and number dependent) and power generation capability (electrode size and reaction kinetics dependent). In terms of cost, system flexibility, quick response and safety concerns for large scale applications, redox flow batteries show great advantages over other types of batteries such as lead acid and lithium ion batteries and are expected to have increasing commercial space through technological development in the future.

Vanadium is available as rare resources in few countries including Australia . The University has good academic relations with various Australian Universities which are facilitated by Austrade for a decade. This may result in establishing energy storage facility at University with the support of Austrade.

Vanadium based energy storage technology which works by employing four different oxidation states of Vanadium, stored in two tanks, as the active materials.



	Vanadium Redox Battery	Lithium
Number of cycles (Lifespan)	35,000+(35-50 years)	~ 300mx (3-5 years)
Low self-discharge (once charged stays charges)	✓	✗
Low environment footprint	✓	✗
Highly expandable	✓	✗
Generates low levels of heat	✓	✗
Charges and discharges simultaneously	✓	✗
Can relese energy instantaneously	✓	✗
Suitable for connection to power grid	✓	✗
Small footprint	✗	✓

9) Urja Satellite:

As the nation contends with the increasing energy demand, the role of conventional and renewable energy becomes primary. Across the world, many of the developed and developing countries have started giving primacy to rapidly increase the volume of energy to propel the overall growth of economies.

The University has vision of developing Urja Satellite to Map energy Resources for Oil and Natural Gas, Wind and Geothermal Energy. Accumulation of Data and Employ Multispectral, Near Infra-Red, SAR (synthetic Aperture Radar) Techniques with required spatial resolution. Currently we are interacting with ISRO for a possible collaboration to integrate with PSLV Mission.

Box Specification:

Dimension: 40cmX 30cmX 40cm
Weight: 10Kg
Altitude: 575Km

Following objects properties may be acquired from distance with dedicated instruments:

- spatial (geometric resolution)
- spectral (frequency resolution)
- intensity (radiometric resolution)
- temporal (revisit time)

Different types of remote sensing:

- Optical and infrared sensors
- High-resolution Multispectral, hyperspectral data
- Launch of the Project – June 2021
- Launch of the Satellite – June 2023

Objective:

- Map Energy resources for Oil & Natural gas, wind, solar and geothermal energy, Wave energy reservoir
- Perform data collection related to land coverage, water bodies, and surface fault detection.
- Accumulate data for crop detection, vegetation, and shoreline.
- Detection of pollution, oil seepage, ocean surface temperature mapping
- Employ multispectral, Near Infra-red, SAR (Synthetic Aperture Radar) techniques with specific spatial resolution.

A translational research center encompassing all these initiatives is envisaged to give impetus for a I 4.0 based ecosystem. The facilities, manpower, student initiatives will revolve around these initiatives.

10) Translational Research Center (TREC) :

Measures are currently underway to contextually reassert ourselves to the new technological demands. Dedicated infrastructure for promoting translational research in the following areas will be set up (TREC-PDPU). Accordingly, new and major facilities pertaining to Additive manufacturing, Cyber physical systems, IoT, Artificial Intelligence, Biomedical Engineering, Nanotechnology, Communication systems will be our specific goals. To this end, we will also involve in generating funding in collaboration with major universities, companies across the Globe to meet this challenge.

A 40 cr facilty dedicated for center of excellence in clean energy, clean water, carbon capture, sustainable production and consumption of energy, electric vehicles, machine learning and ai – based robotics





To achieve the objectives of the Translational Research Centre, the following centre of excellence have been envisaged in various domains.

(a) Affordable and Clean Energy

Center of Excellence in Carbon-Free Energy Options and Energy Conversion: Hydrogen Fuel, Fuel Cell and Energy Storage Green Technology - Bio-fuels and waste-to-energy, conversion, Offshore renewable energy (wind, wave and tidal), Small scale captive energy conversions, Energy system design and optimization, geo-thermal and Solar Energy

(b) Clean Water and Sanitation

Center of excellence in Water Treatment and wastewater management: Decentralized wastewater treatment, Portable water management, Solar Desalination of Seawater/Brackish Water, Water re-use and recycle optimizations.

(c) Carbon Capture

Center of Excellence in carbon-based energy and enhanced Oil Recovery: Enhanced Oil & Gas Recovery, Reservoir Modelling and Simulation, Gas hydrate, Coal bed methane, tight sand gas, Shale gas, City Gas Distribution, Clean Energy- Clean technologies such as coal gasification, carbon capture & sequestration (CCS)/ carbon conversion technologies.

(d) Food Security, Healthcare & Hygiene

Center of excellence for application of nuclear radiation in the non-power application: Radiation induced mutation breeding, Radiation-induced advanced polymers & rubbers, Food irradiation & preservation, nuclear radiation for waste sterilization, radiography & other industrial applications, radiopharmaceuticals.

(e) Advanced Manufacturing

Center for Advanced Materials and Manufacturing: Advanced material & manufacturing - Additive manufacturing, Nanomaterials, Metal joining, Powder process, energy storage, Green materials, and biocompatible polymers, Liquid material synthesis and engineering, IOT enabled Control systems, Machine Learning & AI-based Robotics, Electric vehicles, smart grids.

(f) Sustainable Production and Consumption of Energy

Center for Excellence in Energy Management and Audit: Smart Metering, Micro Grids, Decentralized Distributed Generation (DDG), Household connected appliances (IOT), Energy Monitoring, Digital Energy audits and Digital governance of systems, Electric Vehicles, power quality enhancement

11) Partnerships with Industry & Academia Nationally and Internationally: To realize the above mentioned verticals, continuous engagement with industry and leading institutions is inevitable. One way to explore this engagement is to show our resolve in setting up basic facilities so that the topping up will happen as a serious collaboration. Our institution will also take the lead role to initiate the seeding process and groom the interaction to maximize the collaboration for maximum visibility of the stakeholders.

12) Consultancy Projects: There are several stand-alone facilities which are unique of our campus, where both leading Financial/academic/ research institutions including ONGC, SUZLON, SHELL Hazira, ADANI Gas, NITI AAYOG, Reliance, and other service sector companies come for collaboration and consultancy engagements. We will maintain our interaction and ambience in the same measure to invite wider interaction with industry in all sectors and specializations.

13) Innovation and Startups: The culmination of the above perspectives is to groom newer indigenous technologies, validated and implemented by national and international research partners both from academia and Industry. Hence our thrust will be on innovation, to provide the right eco-system from the first year onwards, so that Innovation will not be compartmentalized but becomes a part of the learning practice and perspective. This culture hopefully will affect the accountability factor and relevance to society.

ENERGY FOR ALL

TRAINING ENERGY SOLDIERS FOR THE NATION

3. TRANSCENDING QUALITY:

Excellence isn't a measure, or a statistic, or a check box on a checklist. Excellence is a feeling. Excellence is a moment. If we chase only abilities and needs.

It's our pleasure to be the driving force for the students in guidance and assistance to achieve both academic and personal goals. We focus primarily on grooming the students and enhancing their academic and interpersonal skill sets and finally making them a wise human beings.

Faculty members are the lifeline of any educational institution, their involvement in academic and research activities is of paramount importance for the success of the institute. Research is the most significant part of the academic career of any faculty. "None of us is as strong as all of us". Students' success and their well-being will always remain the most important priority of PDEU.

A) LOCALLY ENGAGED

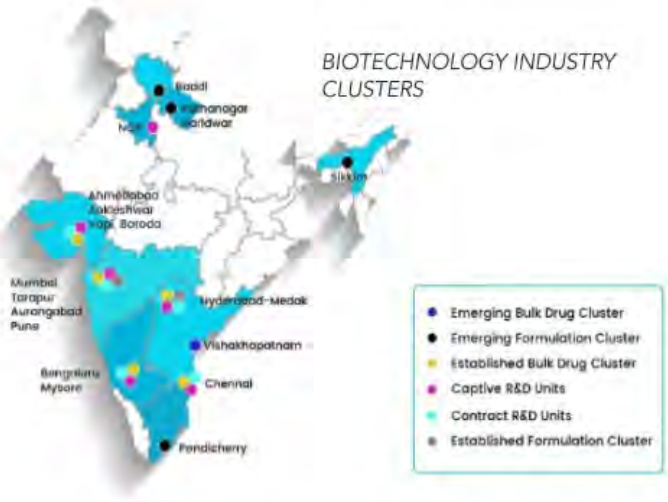
As a prime component of the knowledge corridor, PDEU actively collaboration with the neighboring institution including Gujarat National Law University (GNLU), IIAR, GIDM, ISR, Petrograph, Central University of Gujarat, NIRMA, DAICT, NIPER, and IIT-G. We will work towards forming a consortium to bring facilities of national importance and relevance to local demands.

ONGC – PDEU COLLABORATION ON OIL EXPLORATION

Our Prime Minister Flagship project at Kutch in commissioning 30000 MW hybrid Solar wind Project throws a lot of opportunities for collaboration to work on smart city and smart grid projects.

Another area of collaboration is to work on a High fluid magnetic facility for Biomedical applications. We have many pharma and Biomedical companies. A new formulation for drug therapeutics, biomedical implants throws possibility for medical imaging in pre-medical modules. The state Government initiatives over the past years have resulted in developing biotech Industry Clusters in the State of Maharashtra, Andrapradesh, Karnataka, Gujarat, and NCR which are major contributors.

BIOTECHNOLOGY INDUSTRY CLUSTERS



Improving Innovation Ecosystem: PDEU has established processes and mechanisms for easy creation and nurturing of Startups/enterprises by students (UG, PG, Ph.D.), staff (including temporary or project staff), faculty, alumni, and potential start-up applicants even from outside the institutions. PDPU IIC promotes the culture and spirit of entrepreneurship. PDPU has so far generated 42 IPR's 950 job employments and nurtured 90start–ups. IIC has also generated nearly Rs. 40 Crores. PDPU IIC is also recognized as a nodal institute by the Government of Gujarat, Technology Business Incubator by DST, Registered as Start-up India Incubator under DIPP, Government of India. One of the start-ups "Powertree" has received a 4Crore worth of Work order from the Government of Gujarat to install Solar Tree with various customization.

PDPU received SSIP "Prashansa "Award for Best University Category for the University's outstanding performance in the area of Student innovation and startups.

Under the initiation of the Government of Gujarat, an Impact Assessment study of "Vrundavan Gram Yojana" was carried out by PDPU. Further PDPU has adopted 5 villages under the "Swachh Bharat initiative to give comprehensive rural internship training for all the students at the end of 1st year.

B) NATIONALLY IMPORTANT

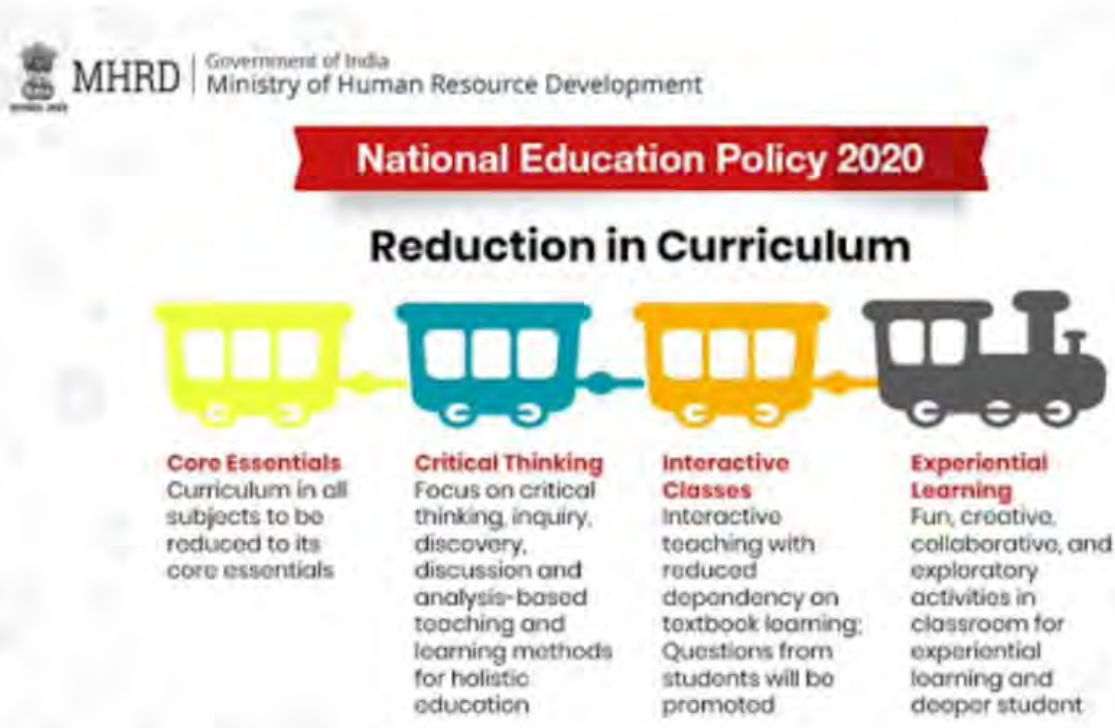
The NEP 2020 has been finalised after detailed consultation process with all stakeholders including State/UT Governments. This Ministry has communicated to all States/UT Governments for implementation of NEP 2020 in letter and spirit.

New Curricular and Pedagogical Structure (5+3+3+4);

I. No hard separations between arts and sciences, between curricular and extra -curricular activities, between vocational and academic streams;
ii. Holistic Multidisciplinary Education with multiple entry/exit options;
iii. Establishment of Academic Bank of Credit;
iv. Setting up of Multidisciplinary Education and Research Universities(MERUs);
v. Setting up of National Research Foundation(NRF);
vi. Exposure of vocational education in school and higher education system;
vii. Professional Education will be an integral part of the higher education system. Stand-alone technical universities, health science universities, legal an agricultural universities, or institutions in these or other fields, will aim to become multi -disciplinary institutions.
viii. Internationalization of Education
ix. Establishing a National Mission for Mentoring.
x. Single overarching umbrella body for promotion of higher education sector including teacher education and excluding medical and legal education- the Higher Education Commission of India (HECI)-with independent bodies for standard setting- the General Education Council; funding-Higher Education Grants Council (HEGC); accreditation- National Accreditation Council (NAC); and regulation- National Higher Education Regulatory Council (NHERC);
xi. Establishing National Mission on Foundational Literacy and Numeracy;
xii. Emphasis on promoting multilingualism and Indian languages;
xiii. Setting up of a new National Assessment Centre, PARAKH (Performance Assessment, Review, and Analysis of Knowledge for Holistic Development);
xiv. Equitable and inclusive education - Special emphasis given on Socially and Economically Disadvantaged Groups(SEDGs);
xv. A separate Gender Inclusion fund and Special Education Zones for disadvantaged regions and groups;
xvi. Increasing GER in higher education to 50%;
xvii. Expansion of open and distance learning to increase GER.

1. Credit sharing between liberal arts and basic sciences: PDEU offers a 60:40 ratio in credits sharing between arts and science courses for obtaining B.Sc(Hons.) in sciences. This is a flagship program at PDEU.
2. Mandatory credits of 10% of the 160 credits will be from social sciences for the 4yrs B.Tech degree.
3. PDEU offers only 4 yr B.A., B.Sc., B.Com and BBA courses, thus becoming relevant to the proposed 4 year UG model.
4. Credits from curricular, extracurricular and co-curricular courses forms an integral part of the Total credits for UG and PG courses. For example, Mandatory rural internship and industry internship are part of the system.
5. We will strive to represent as an effective MERU campus.
6. We would introduce all B.Voc courses for enhanced skill development programme.
7. We would qualify to be a Stand Alone Technical University.
8. We will play an active role in the national mission for mentoring.
9. We will meet all the needs for international accreditation and will strive to attract and provide higher education for the universities abroad.

We would like to position ourselves as a strong contender for MERU status.



C) GLOBALLY COMPETITIVE

The world is more interconnected and interdependent and students need to be globally competent to succeed. This means that students need the awareness, skills, and knowledge to understand, navigate and flourish in this increasingly global economy. However, we continue to hear that while students may be academically prepared, they are not emotionally ready for the workforce. To be college and career-ready, students need to be prepared both academically, as well as behaviorally. This includes what we often refer to as "soft skills," such as problem-solving, adaptability, work ethic, and the ability to communicate in a business setting.

In the period of knowledge development, technological innovation is visualized as the prime driver to create and maintain a competitive advantage. Interest in technology development and business innovation increased as concern mounted over the economic power of the nation and competition from abroad. Theoretical models emphasize that there are two basic modes of advancing technology. One is innovation (developing one's new technologies) and the other is adoption (introducing technologies that have been devised elsewhere). Adoption of technology from overseas enhances living standards substantially, and even to achieve long-term growth based on the continuous technological innovations achieved abroad. But technology adoption has its limitations as well. Technological progression in global business can lead to economic growth because they contribute to the manufacture of new goods, new services, creating new jobs, and new capital.

Few Emerging Technologies for Global Competence:

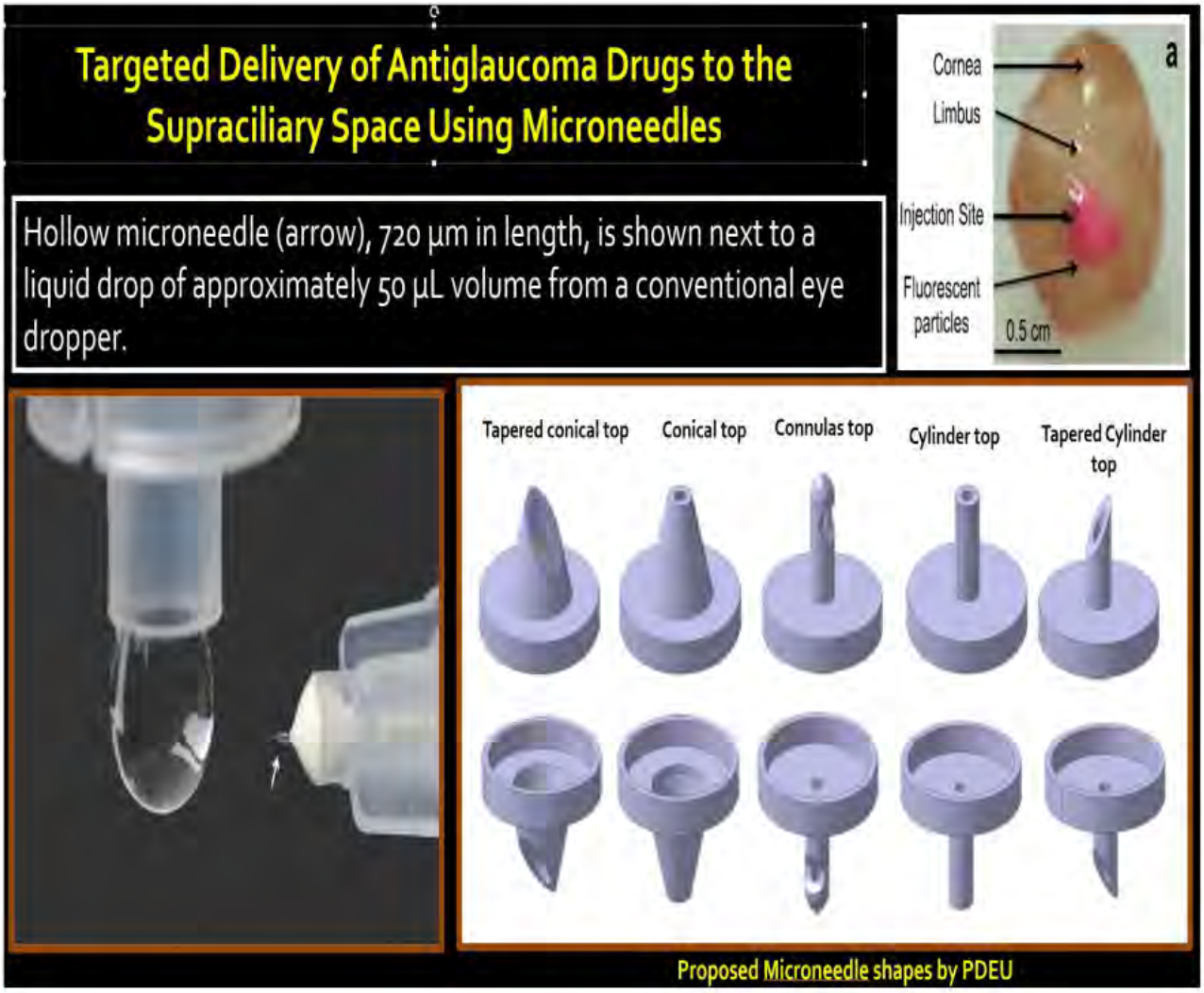
1) Laser Micromachining : Design, Fabrication of Microneedles for Ophthalmic Drug Delivery to the Posterior Segment of the Eye

Drug delivery to the eye is challenging, and delivery of macromolecules to the back of the eye is especially difficult because delivery across the cornea after topical administration has very low bioavailability, systemic delivery is often accompanied by side effects, and intraocular injections introduce safety concerns. Therefore, improved ocular drug delivery methods are needed that locally deliver useful quantities of drugs to the eye for treatment of anterior- and posterior segment diseases without risk of vision-threatening complications. Hence it is proposed to develop microneedle using a laser micromachining process for ophthalmic nano-drug delivery. The scope of the project includes a) Design of microneedle, b) Fabrication of microneedle, c) delivery of the fluorescent dyes in different ocular sites using ex vivo model and in vivo model, d) Compare the bioavailability of the native drug given as eye drops verses that injected using microneedles in the aqueous chamber (glaucoma drug)

Nano-enabled systems and devices can find novel therapeutic solutions for crossing the blood-retina barrier and make sustained availability of drugs in desired therapeutic concertation in different compartments of the eye. A number of serious conditions can affect the retina (the receptive "screen" at the back of the eye where images are formed), such as age-related macular degeneration, the most common cause of severe vision loss

among people over age 60; and diabetes-related disorders, the leading cause of blindness in people under 60. Unfortunately, the retina historically has proven difficult to target directly with newly available drugs. Traditionally, medications for the eye have been delivered in the form of eye drops. Injections directly into the eye (intravitreal injections) have historically been used for the treatment of acute disorders, such as an acute intraocular infection. Alternative methods of delivering drugs to the eye are to simply take a pill, which delivers the drug to the entire body, including the eye, or to inject medication around the eye and allow it to diffuse through the porous white part (sclera) into the target tissues within the eye. None of the above options, though, selectively targets the retina, for injections in the skin as well as the eye, physicians use regular hypodermic needles, even when the surface for penetration is very thin. The microneedle's tiny size about half a millimeter long (approximately equal to the thickness of a dime) makes the new implement an ideal alternative. In view of this, we have conceived five shapes of microneedles viz. a) tapered conical top, b) simple conical top, c) Connulas top, d) simple cylinder, and e) tapered cylinder. The preliminary design conceived is shown below. The proposed design has the bottom cup which can be directly inserted into the existing gauge 28 or 30 gauge needle. The tapered cylinder design is more robust and proposed to fabricate. It is proposed to fabricate the microneedle by laser micromachining.

The fabricated microneedle will be used to deliver the fluorescent dyes in different ocular sites using the ex vivo model and in vivo model. A comparative analysis on the bioavailability of the native drug given as eye drops verses that injected using micro needles in aqueous chamber (glaucoma drug) will be done.



2) High Field magnetic facility for imaging and Spectroscopic investigation: Proposal for 1000 MHz Nuclear Magnetic Resonance (NMR) Spectrometer: First of its kind in the country.

Currently NMR has become a sophisticated and powerful analytical technology that has found a variety of applications in many disciplines of scientific research, medicine, and various industries. Modern NMR spectroscopy has been emphasizing the application in biomolecular systems and plays an important role in structural biology. With developments in both methodology and instrumentation in the past two decades, NMR has become one of the most powerful and versatile spectroscopic techniques for the analysis of biomacromolecules, allowing characterization of biomacromolecules and their complexes up to 100 kDa. Together with X-ray crystallography, NMR spectroscopy is one of the two leading technologies for the structure determination of biomacromolecules at atomic resolution. In addition, NMR provides unique and important molecular motional and interaction profiles containing pivotal information on protein function. The information is also critical in drug development. Some of the key applications of NMR spectroscopy are listed below:

- **Solution structure** The only method for atomic-resolution structure determination of biomacromolecules in aqueous solutions under near physiological conditions or membrane mimeric environments.
- **Molecular dynamics** The most powerful technique for quantifying motional properties of biomacromolecules.
- **Protein folding** The most powerful tool for determining the residual structures of unfolded proteins and the structures of folding intermediates.
- **Ionization state** The most powerful tool for determining the chemical properties of functional groups in biomacromolecules, such as the ionization states of ionizable groups at the active sites of enzymes.
- **Weak intermolecular interactions** Allowing weak functional interactions between macrobiomolecules (e.g., those with dissociation constants in the micromolar to millimolar range) to be studied, which is not possible with other technologies.
- **Protein hydration** A power tool for the detection of interior water and its interaction with biomacromolecules.
- **Hydrogen bonding** A unique technique for the direct detection of hydrogen bonding interactions.
- **Drug screening and design** Particularly useful for identifying drug leads and determining the conformations of the compounds bound to enzymes, receptors, and other proteins.
- **Native membrane protein** Solid state NMR has the potential for determining atomic -resolution structures of domains of membrane proteins in their native membrane environments, including those with bound ligands.
- **Metabolite analysis** A very powerful technology for metabolite analysis.
- **Chemical analysis** A matured technique for chemical identification and conformational analysis of chemicals whether synthetic or natural.
- **Material science** A powerful tool in the research of polymer chemistry and physics.

In view of above it is proposed to set up a state-of-the-art 1000 MHz Nuclear Magnetic Resonance (NMR) Spectrometer at the PDEU. We are 10 years behind in bringing 1GHz NMR into our country when Japan demonstrated the first facility in the year 2001 as seen in the figure. The major hurdle faced by the R&D centers at various advanced laboratories is the lack of adequately trained and Good Laboratory Practice (GLP) oriented personnel. This forms a major set back when the innovative ideas especially in the field new & novel molecule innovation or characterization is concerned. The lacunae become more evident when dealing with drug discovery in India. The same inadequacy is seen even among the national laboratories and other testing and research centers. This lacunae needs to be addressed very diligently and the proposed program is a step in this direction. This proposal has been planned to address this need of trained personnel as well as to undertake advanced research at PDEU.

Nuclear Magnetic Resonance (NMR) as a technique has witnessed unparalleled growth over the last few decades. The applications have encompassed all branches of science including physics, chemistry, biology, and medicine, and new fronts are emerging rapidly. The research and technology fronts have been advancing simultaneously, each providing an impetus to the other. The developments have been phenomenal, on both fronts, and this area of research has become highly multidisciplinary in character, encompassing not only physicists, chemists and biologists, but also engineers. NMR has emerged as an indispensable tool for every institution engaged in basic science research.

In view of this, the present proposal aims is to establish a state-of-the-art NMR facility, at the PDEU. NMR will be taught to the students of PDEU as well as neighboring universities / institutes as an elective course in the final years and the students will be able to undertake projects in a variety of disciplines using this technique. This facility will provide an enormous research potential for the faculty of University Departments.

NMR in Nano Science and Nano Technology

Organic light-emitting diodes (OLEDs) have been the subject of intense research for the past two decades, aiming for display, lighting, and other applications almost exclusively in the visible region. An OLED is a (LED) in which the emissive electroluminescent layer is a film of organic compounds which emit light in response to an electric current. This layer of organic semiconductor material is situated between two electrodes. Generally, at least one of these electrodes is transparent. There are two main families of OLEDs: those based on 1) small molecules and 2) those employing polymers. Light-emitting thin-film system are now built with at least one heterojunction- the interface between two organic layers. The hole transport layer (HTL) is easily oxidized, usually using bis tri aral amines. The electron transport layer (ETL) is easier to reduce and more difficult to oxidize. In electrochemical terms, the HTL should be composed of chemicals that are easy to oxidize and form stable cation radicals, and the ETL should be composed of chemicals that are easier to reduce and form stable radical anions. This results in energy offset between the two organic layers. Electrons injected into the ETL layer have a large energy barrier to surmount to move into the HTL. The holes injected into the HTL have a large energy barrier to move into the ETL layer. As a consequence, at low applied fields, the holes and electrons build up at or near the interface.

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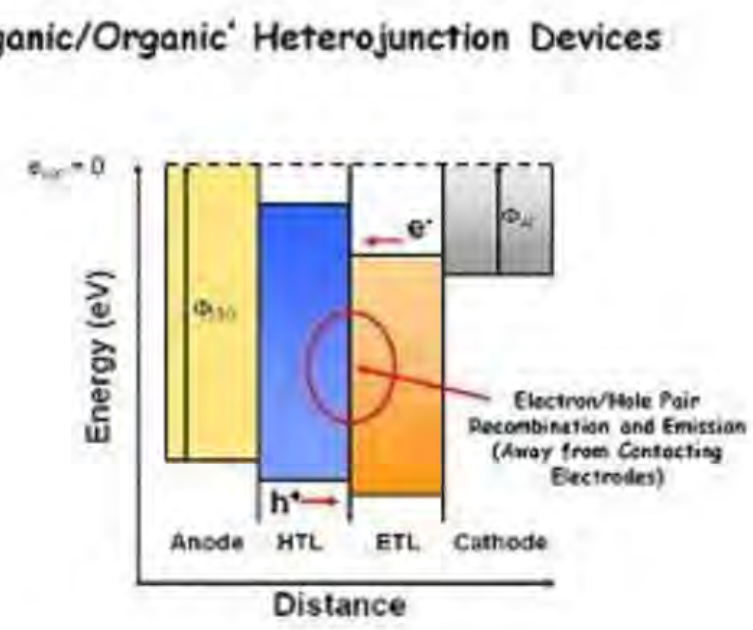


The Role of NMR in Energy & Materials

The analytical power of NMR will be key to the great technological challenges that face mankind concerning the sustainable energy supply for the future. Discoveries and breakthroughs in sustainable energy technologies depend strongly on progress of materials research to yield insight in the structure-function relations of new materials. NMR has developed into the most versatile tool to study both ordered and disordered materials. Ongoing research programs comprise photovoltaic conversion, hydrogen storage and production, nuclear fusion and clean combustion and new ones are proposed for hybrid conversion of biomass, solar fuels, distribution of electricity and energy storage. Examples of the application of NMR technology in energy research are highlighted below.

Solar cells

Solar energy is one of the most attractive supplies of sustainable energy, because enough solar radiation reaches the Earth's surface every hour to meet the world's annual energy needs. The problem lies in harnessing this resource. A major challenge is finding an optimal balance between efficiency and durability. This is approached from different sides, either by mimicking the processes taking place in nature to create solar fuels. Alternatively, an important supply in the near future is based on inorganic materials that convert light into electricity. Understanding the structure and functional properties of these materials at the nanometer scale, solid-state NMR techniques are indispensable. This calls for highfield implementations and novel NMR probes with microcoils to improve sensitivity to the level that single layers of the photovoltaic material can be analyzed.

Batteries

The introduction of sustainable energy supplies is accompanied by the need for more efficient energy storage media. Such developments require a fundamental understanding of the relation between the substance that contains the energy and the storage medium. For example, to design materials optimized for hydrogen storage and release (e. g. for cars) we need knowledge of the interactions at the atomic scale between the components of these complex materials. Thus, analytical methods will play a vital role in the production of successful battery materials.

Recent work on battery materials has shown that modern, high field NMR can characterize disordered materials, and in particular the crucial small and mobile atoms, such as hydrogen and lithium. It can also be used to analyze batteries during operation, helping to understand the charging/discharging process, the performance, and the aging. A range of NMR techniques, like pulsed-field gradient techniques and imaging approaches, can also be applied to study transport phenomena within the novel materials, both in bulk and thin films.

Biofuels and other biomaterials

In a sustainable economy, plant products are used for the so-called 4F-products, not only for Food and Feed (animal foods) but also as an alternative source of raw materials (Fibers/chemicals) and Fuel, to replace fossil fuels. The development of a bio-economy requires improvement of the knowledge of the plants and microbes providing the renewable resources, in soils that need to be properly managed for sustainable bio-production as well as in bio-product processing. For example, economical catalytic routes

have to be developed to break down biomaterials, such as cellulose, into compounds for the chemical industry. Many NMR methods, like flow NMR, imaging and high-resolution solution, and solid-state NMR, can contribute to this development, for example in the following areas:

- Analysis of key plant functions, like distribution of water, carbon, and nutrients, and structures.
- Determination of water and substance transport in soils.
- Composition and structure analysis of plant-based products.
- Control of the processing of biological materials to measure quality and conversion efficiency.

NMR scenario in India

About 230 NMR spectrometers were bought and installed in the country (since mid-1970). A rough breakup of these, in various disciplines, is as follows:

Although in the 1960s NMR started as a subject of research interest, confined to a few Departments in India, it has steadily grown as an invaluable tool for organic chemists. Even though this segment of science, in research labs and pharmaceutical industries, is still one of the major investors in NMR, in the last decade, NMR in India is diversifying to other areas such as solid-state NMR of polymorphic samples, LC-NMR of drug metabolites, mixtures, NMR micro, and mini imaging, and multidimensional NMR of biological samples.

The frequency-wise breakup of NMR bought/installed since mid-1970 is as given in the following table.

[Source of Data: C.V.Manjunath, NMR Spectroscopy in India, Analytical Anacor 2009]

3) ADDITIVE MANUFACTURING BEYOND MECHANICAL DEVICES:

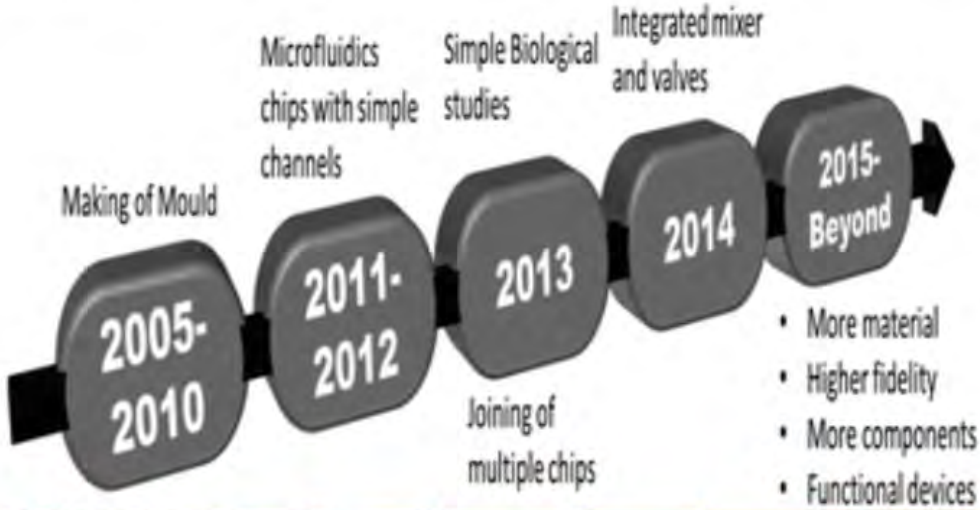
3D structured Nano / Micro Materials for Technology System development in Electronics/Stealth/Maritime/Health Care Industries

Additive manufacturing techniques such as 3D printing offer a potential solution via the ability to rapidly create computer-aided design (CAD) models by slicing them into layers and building the layers upward using biological cells as inks in the precise anatomic geometries of human organs. The ability to three-dimensionally interweave biological tissue with functional electronics could enable the creation of bionic organs possessing enhanced functionalities over their human counterparts. In view of this it is proposed to create a Centre for Excellence in 3D structure Nano / Micro Materials for Technology System development in Health Care Industries.

Recently, several reports have described the coupling of electronics and tissues using flexible and/or stretchable planar devices and sensors that conform to tissue surfaces, enabling applications such as biochemical sensing and probing of electrical activities on surfaces of the heart, lungs, brain, skin, and teeth. However, attaining seamless three dimensionally (3D) entwined electronic components with biological tissues and organs is significantly more challenging.

In view of potential application of the 3D additive technology, it is proposed to create a Centre for Excellence in 3D structure Nano / Micro Materials for Technology System development in Health Care Industries with following wings.

- **Biomaterials Division:** Synthesis of Biological materials such as living cells, composites, etc.,
- **Smart Materials Division:** Synthesis of nano materials(polymers and metals) for 3D Rapid prototyping
- **Polymer 3D Printing Division:** flexible electronics and Biomedical device/prosthesis.
- **3D Metal Rapid Prototyping Division:** Artificial Human Parts including Hip joints, ribs and heels.
- **Preclinical Division:** Up gradation of existing GLP grade animal hose facility for higher animal models such as swine model.



4) CARB-X (Combating Antibiotic Resistant Bacteria)

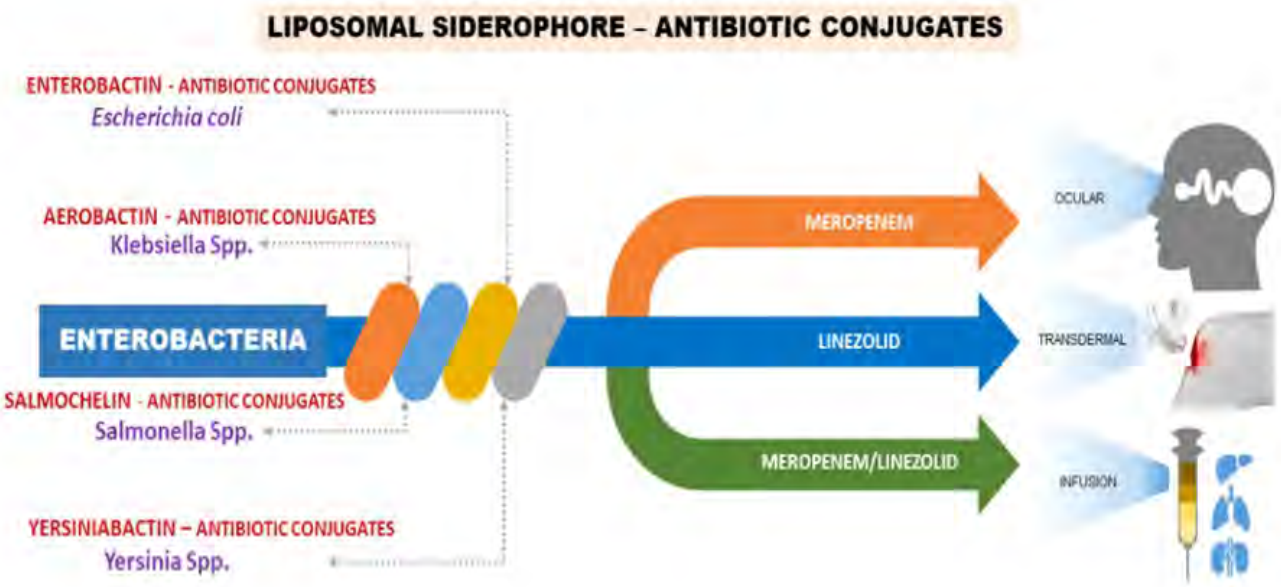
Infectious diseases account for nearly one-fifth of the death that occurs worldwide. Sustained drug resistance is one of the biggest challenge in treating infectious diseases. Pathogens belongs to enterobacteriaceae are the commonest cause of bacterial meningitis and it remains a greater medical challenge to physicians and health organizations around the world. Further several pathogens of enterobacter family are ranked on high priority list of WHO for developing a new category of antibiotics. Development of new broad-spectrum antibiotics is increasingly difficult as it involves huge investment and requires much time. Thus, alternative approaches, such as drug repurposing, are needed to meet the challenges of outbreaks and the emergence of drug resistant infectious diseases. Repurposing and revival of the drugs are the new trends of the pharmaceutical strategies to treat the particular infection.

Carbapenems and oxazolidinones are a class of highly effective antibiotic agents commonly used for life-threatening infections. Rapid development of resistance is a major limitation factor of these antibiotics. Drug repurposing, is an ideal strategy to identify newer applications for the existing approved molecules like meropenem (MER) and linezolid (LIN). Nano tailored MER-LIN antibiotics with siderophores greatly impedes the drug resistance, alleviates the side effects and also extend the life span of current generation antibiotics. Bioactive Nano scaffolds in combination with MER-LIN antibiotics is an emerging technology with high clinical significance. Upon successful preclinical validation this hydrid nano formulations (Transdermal scaffolds, Nano microneedles, and Nano infusions) may have wide range of scope in treating meningitis, diabetic ulcers and other infective wounds at clinical level.

Meningitis being an emergency neurological condition often requires parenteral drug delivery, preferably by the intravenous route, recently ocular delivery route has been adopted to enhance the delivery of drugs to CNS in patients where intravenous access is not possible. It was evident through the WHO survey that meningitis causing bacteria's are becoming vulnerably more resistant to most of the commonly used antibiotics. Antimicrobial resistance (AMR) becomes major burden on public health and economic stability of societies all over the world. AM resistant bacteria's can cause serious life threatening infections and present growing challenges to health security. Ocular microneedle based technique is an emerging and minimally invasive mode of drug delivery to circumvent the BBB. This technique may provide efficient treatment strategy for meningitis and other neurodegenerative disease. Microneedle based drug administration may enhance the target drug delivery to the brain with improved bioavailability. Diabetic ulcer showing higher prevalence in patients more than 60 years old. The burden of DU is expected to rise double the fold in the future, giving that the prevalence of its predisposing factors. Majority of the case DU ends in amputation, especially in the case of wound infection. In tissue regeneration, the paramount importance is to provide a fire wall around the ECM to prevent bacterial infection which can colonise where excaudate prevail. Whereas transdermal nano scaffolds with hydrogels provides 3D architecture for cell proliferation, a rationale synthesis of siderophore-antibiotic conjugate becomes a timely intervention. Nano encapsulated MER- LIN antibiotics tagged with siderophores are highly specific in action there by it provides maximum comfort to the patient in less time. Further scaffold with growth factors promotes effective wound healing. Products with PEGylation technology provides safe and reliable delivery of therapeutics thereby chances

of occurrence of serious adverse event shall be avoided. Hence with this newer technology, the life span of existing antibiotics may be prolonged and need for newer therapeutics shall be avoided.

The use of siderophore–antibiotic conjugate for the treatment of many bacterial infections is a powerful approach in targeted drug delivery system. Hydrogels provide a regenerative medicine platform with their ability to create an environment that supports endogenous infiltrating cells and enables these cells to restore tissues lost to disease or trauma. Many of these materials have already been extensively tested both in vitro using different cell types, and in vivo with different pre-clinical animal models. Nano tailored MER-LIN antibiotic conjugates tagged by selective siderophores is the first ever Nanoengineered scaffold that offers the dual advantage of combating drug resistant pathogen and promotes cost-effective industrially viable technology for effective management of bacterial meningitis, diabetic ulcer and infective wounds.



The proposed outcomes of the present research work

1. Nano encapsulated antibiotics tagged with siderophores are highly specific in action thereby it provides maximum comfort to the patient in less time.
2. Product with PEGylation technology provides safe and reliable delivery of therapeutics thereby chances of occurrence of the serious adverse event shall be avoided. Hence with this newer technology, the life span of existing antibiotics may be prolonged and the need of newer therapeutics may be avoided.
3. Exploration of cost-effective and clinically efficacious nanoformulations for treating patients from the lower economic zone.
4. Reduction in total health care cost on clinical management of meningitis.
5. Scale-up operation for the production of nano-enabled formulations with industry collaboration.

5) Energy Storage for EV Charging Stations:

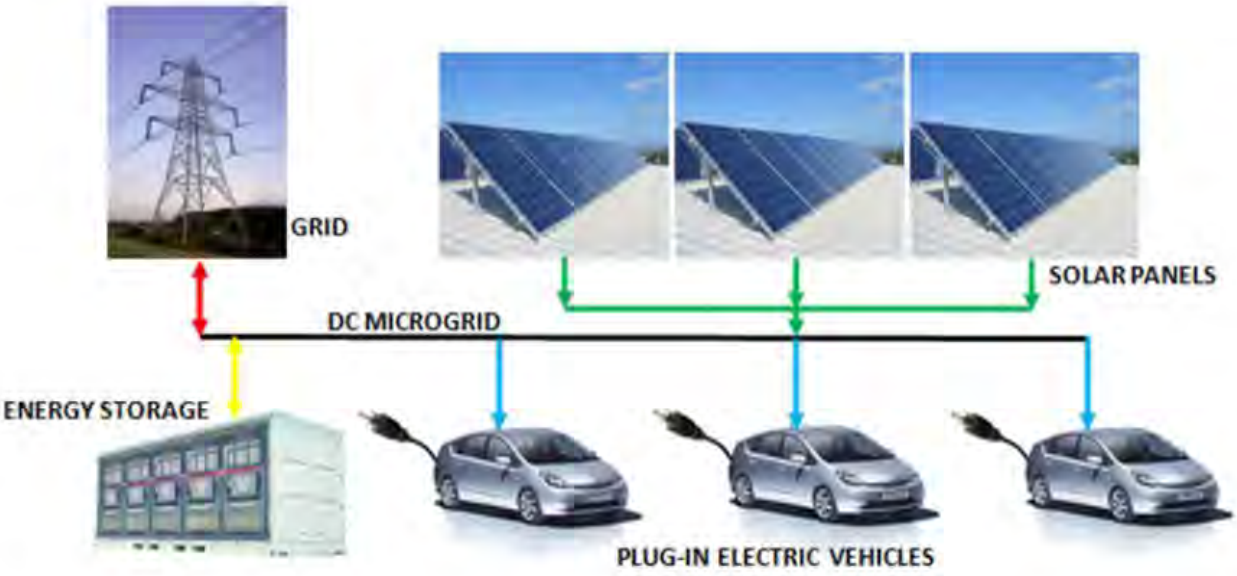
Numerous EV companies and startups such as Okinawa, Crayon Motors, EbikeGo, Mobycy, Tunwal, Deltic, and Lohia have hit the ground running. The businesses listed above have one thing in common - they all use Made in India Li-ion batteries manufactured by Delhi-based iPower Batteries.

Other leading manufactures for Electric cars include: Tesla (TSLA), Nio (NIO), Switchback Energy Acquisition Corp. (SBE), Plug Power (PLUG), QuantumScape Corp. (QS), Ford Motor Co. (F) and General Motors Co. (GM).

Until now, however, redox flow batteries have had the disadvantage of storing significantly less energy than lithium-ion batteries. The vehicles would only be able to cover about a quarter of the normal distance – around 25 kilometers – which means the driver would have to recharge the batteries four times as often. "We can now increase the mileage four or fivefold, to approximately that of lithium-ion batteries."

A new type of redox flow battery presents a huge advantage for electric cars. If the rechargeable batteries are low, the discharged electrolyte fluid can simply be exchanged at the gas station for recharged fluid – as easy as refilling the petrol tank. Redox flow batteries (RFB), which continue to mature, have the potential to be fast recharging contenders. Refuelling is possible by rapid pumping of the reactants into the batteries' tanks. Another feature of RFBs that makes them attractive for EV applications is the separation, in terms of physical location and sizing, of the energy and power components. This adds a degree of flexibility that allows the optimization of the power and energy components for a specific vehicle configuration and performance.

PDEU is in the process of demonstrating the integration of a Microgrid for a Plug-in Electric Vehicle Charging Station in combination with Solar PV and Energy storage.



6) Enhanced Oil Recovery :

Pandit Deendayal Energy University is one of the government-recognised institute for EOR Screening as per the MoPNG's Circular of 10th October 2018. Till date, PDEU has completed EOR screening worth of around Rs. 1 Cr and is considered as established Centre of Research in Enhanced Oil Recovery. With already completed EOR screening projects PDEU is the best performing EOR Screening Institute out of all the EOR Screening Mandate Research Institutes in India. We have state of Art equipments; large number of software; and best technical experts in India. Till date it has completed 5 major EOR screening projects, most of our results are at present being implemented in field. Currently Experts of SPT-PDEU are qualified to take up research projects in the niche areas of:

i. Low salinity and additives (polymer/surfactant/nanoparticles) EOR

The use of additives in low salinity water for their suitability for injection into oil-bearing sandstone and carbonate reservoirs to improve the oil recovery performance in an enhanced oil recovery process by this method. This is an economic and environmentally friendly method specifically suited for offshore reservoirs where sea water is readily available and their salinity could easily be reduced.

ii. Water alternating carbon dioxide (CO2 WAG) EOR and subsequent CO2 geo -sequesteration

This allows the oil to first expand and become better able to flow because of the CO2, and then the water increases the pressure in the reservoir to flush this newly freed oil to production wells. In this process a portion of CO2 gets sequestered in the rock formation which is helpful for climate change implications.

iii. High temperature microbial EOR

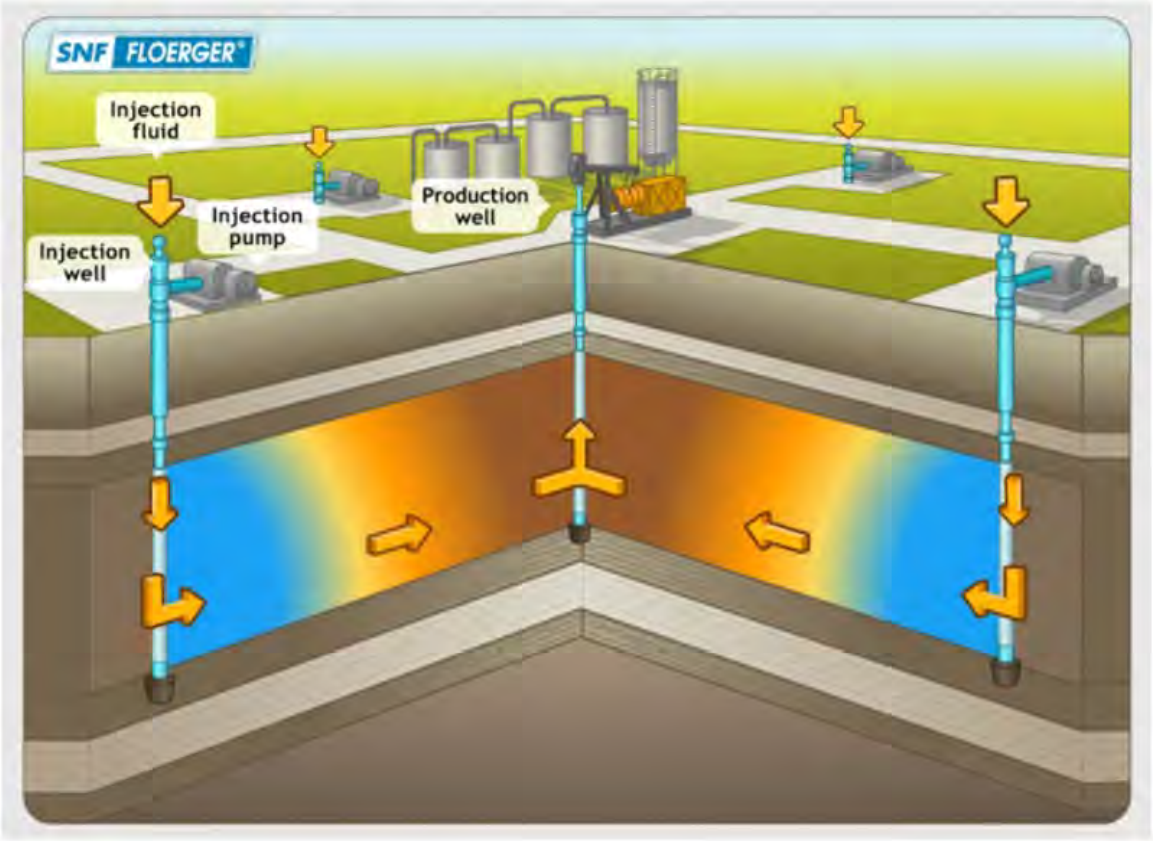
Microbial enhanced oil recovery (MEOR) is an attractive, alternative oil recovery approach, which is claimed to potentially recover up to 50% of residual oil by injection of microbes. The in situ production of biological surface-active compounds (e.g., biosurfactants) during the MEOR process does not require vast energy inputs and are not affected by global crude oil prices. Compared to other EOR methods, MEOR can be an economically and more environmentally friendly alternative.

iv. Steam Assisted Gravity Drainage (SAGD) EOR for heavy oil

Steam-assisted gravity drainage is an enhanced oil recovery technology for producing heavy crude oil and bitumen. It is an advanced form of steam stimulation in which a pair of horizontal wells is drilled into the oil reservoir, one a few metres above the other. High pressure steam is continuously injected into the upper wellbore to heat the oil and reduce its viscosity, causing the heated oil to drain into the lower wellbore, where it is pumped out.

v. Alkali Surfactant Polymer (ASP) EOR - high temperature high salinity

Field performance shows that the incremental oil recovery factor from alkaline projects was low. Chemical EOR experience tells us that the mobility control is very important. Thus, the combination of alkaline flooding and polymer flooding is expected to improve alkaline flooding performance.



vi Electromagnetic heating EOR

Electromagnetic heating of oil wells and reservoirs refers to thermal processes for the improved production of oil from underground reservoirs. The source of the heat, generated either in the wells or in the volume of the reservoir, is the electrical energy supplied from the surface. This energy is then transmitted to the reservoir either by cables or through metal structures that reach the reservoir. The main effect has been the reduction of the viscosity of heavy and extra heavy crudes and bitumens, with the corresponding increase in production.

vii. Ionic liquid as green solvent for EOR

Ionic liquids are gaining much attention as green chemicals due to their unique properties such as extremely low vapor pressure, high thermal and chemical stability, low toxicity and possibility of tuning their cation and anion moieties to make them task -specific.

GLOBALIZATION

Study In India Program

100+ International student from abroad visited PDPU for Study in India Program.

AIESEC @ PDPU

350+
PDPU students have been benefited till Oct' 19 for Outbound Projects

400+
International students from abroad visited PDPU for Inbound Projects

International Exposure Program

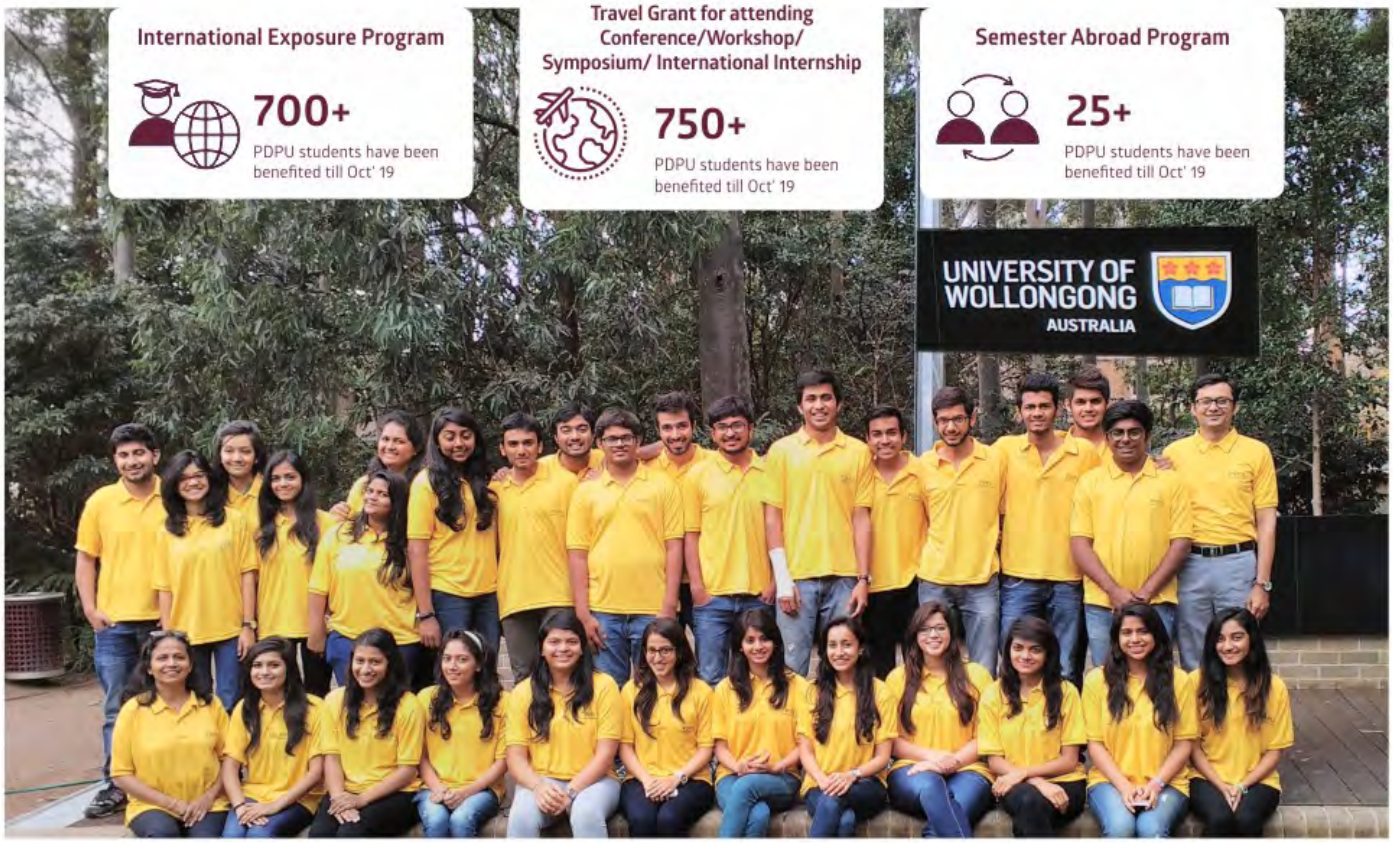
700+
PDPU students have been benefited till Oct' 19

Travel Grant for attending Conference/Workshop/ Symposium/ International Internship

750+
PDPU students have been benefited till Oct' 19

Semester Abroad Program

25+
PDPU students have been benefited till Oct' 19



PDPU STANDS WITH HUMANITY IN OUR FIGHT AGAINST COVID-19

OUR PATENTED CONTRIBUTIONS INCLUDE

- Design, Production and Evaluation of ICU Ventilators in association with other partners
- Research on "Electrospun spinning Polyvinylpyrrolidone (PVP) layered Nanofibre for composite surgical mask"
- Research on "Rational drug delivery systems with Pegylated Liposomes: Drug repurposing of broad spectrum Antivirals & Antimalarials"

eagle

EGL-101 ICU VENTILATOR

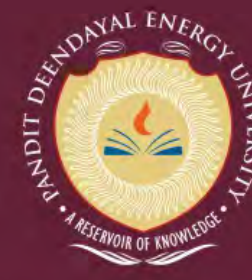
Advanced Microprocessor Controlled Ventilator

Technically Evaluated by

PDPU

MAKE IN INDIA

LIFE AT PDPU



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