IUSSTF

INDO-U.S. SCIENCE AND TECHNOLOGY FORUM

ANNUAL REPORT 2020-21

Catalyzing Indo-U.S. Science & Technology Cooperation

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Catalyzing Indo-U.S. Science & Technology Cooperation

IUSSTF
Indo-U.S. Science and Technology Forum

INDO-U.S. SCIENCE AND TECHNOLOGY FORUM
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www.iusstf.org

Contents

From the Executive Director's Desk

This past year will go down in history as one that saw nations around the world confront a public health challenge not seen since the 1918 influenza pandemic. While our resilience has been tested and the future seems fraught with uncertainty, the global scientific community has given us reasons to be hopeful. From genome sequencing, diagnostics and therapeutics, to the development of new vaccines in record time, science and technology are playing a critical role in addressing COVID-19 challenges. The pandemic has highlighted the need for global partnerships and networks that leverage expertise across geographic and disciplinary boundaries to accelerate the development of innovative solutions.

The Indo-U.S. Science and Technology Forum (IUSSTF) has played a small albeit critical role in supporting global efforts to address the pandemic. Despite the unprecedented crisis and the operational constraints, IUSSTF launched two new initiatives in April 2020 to harness the combined expertise of the Indian and U.S. S&T communities. The call for ***COVID-19 Ignition Grants***, under the aegis of the U.S.-India S&T Endowment Fund, encouraged out-of-the-box, innovative, entrepreneurial initiatives that addressed the development and implementation of new technologies, tools, and systems to address COVID-19 related challenges. The ***Indo-U.S. Virtual Networks for COVID-19*** initiative sought to facilitate partnerships between teams of Indian and U.S. scientists engaged in COVID-related research, leveraging existing infrastructure on both sides to further advance and accelerate the research. The COVID-19 calls highlight IUSSTF's ability to respond quickly to global challenges, and the pivotal role the organization plays in facilitating collaborations between U.S. and Indian scientists.

While the battle against the pandemic is ongoing, countries are looking to rebuild their economies in a post-COVID world. Climate Change continues to be one of the biggest challenges facing our planet, and countries are focusing on renewable energy as a key to mitigating and reducing greenhouse gas emissions. Under an MoU with the U.S. Department of Energy, IUSSTF and its implementation partners, the Indian Institute for Human Settlements (IIHS) and the Alliance for an Energy Efficient Economy (AEEE), launched the Solar Decathlon India (SDI) initiative in the Summer of 2020. SDI is a unique design challenge for undergraduate and postgraduate students from Indian colleges and universities to

address Climate Change by developing innovative, net-zero energy and climate resilient solutions for the building sector in India. In just the first year, over nine hundred students representing one hundred and three institutions from fifty-one different cities across India have signed up to participate in the design challenge.

IUSSTF is uniquely positioned to identify "leading edge areas" that are high priority for both nations, bringing together key stakeholders to help create synergies, and supporting workshops/ networking opportunities to initiate new collaborations. One such area that holds incredible promise to disrupt and transform several sectors of the economy is Artificial Intelligence. In March 2021, IUSSTF launched the **U.S. - India Artificial Intelligence (USIAI) Initiative**, a unique opportunity for the world's two largest democracies to strengthen their strategic partnership by focusing on AI cooperation in critical areas that are priorities for both countries. USIAI will serve as a platform to discuss opportunities for bilateral AI R&D collaboration, share ideas for developing an AI workforce, and recommend modes and mechanisms for catalyzing partnerships. In the coming months, IUSSTF will organize a series of Roundtables and Panels to gather input from different stakeholder communities.

With the lockdown, travel restrictions, and limited access to university campuses, many of the visitation programs were placed on hold. Despite these disruptions, IUSSTF recognized the importance of engaging the scientific community and organized webinars and conclaves. These events provided platforms for networking and an opportunity to highlight the accomplishments of our awardees. IUSSTF was also able to successfully implement the IUSSTF-Viterbi internship program in virtual mode.

The Annual Report provides a summary of IUSSTF's activities for the Indian fiscal year 2020-21 and highlights the contributions of our awardees. We invite you to follow their stories by perusing our newsletter CONNECT or following our social media handles.

I would like to express my deepest gratitude to our Board Members, partners, stakeholders, and well-wishers who have been part of IUSSTF's journey over the years and look forward to your continued support. I would also like to acknowledge the outstanding IUSSTF Team for their dedication and hard work during these extraordinary times.

As we look to a post-COVID future, IUSSTF must adapt to the changing S&T landscape and evolve into a proactive, agile, science-forward organization. We look forward to working with our stakeholders to ensure IUSSTF continues to play a pivotal role in strengthening the S&T partnership between our two democracies.

Dr. Nandini Kannan
Executive Director, IUSSTF

Introduction to IUSSTF

IUSSTF: The Genesis

The Indo-U.S. Science and Technology Forum (IUSSTF) is a bi-national organization jointly created by India and the United States of America, through a formal agreement signed by the two Governments on March 21, 2000. IUSSTF acquired legal status a few months later, when it was registered as a Society under the "Societies Registration Act" in India in June 2000, with its office at New Delhi.

IUSSTF is also the secretariat for the **U.S. - India Science and Technology Endowment Fund**, which was jointly set up later by the two Governments, through a separate agreement in the year 2009.

The Department of Science and Technology (DST) of the Ministry of Science and Technology, Govt. of India, and the U.S. Department of State, are the arms of the two Governments that overview the functioning of IUSSTF through a Governing Body, having equal representation from both sides.

IUSSTF: Vision, Mission and Objectives

Vision

Excellence in Science, Technology and Innovation space through collaborative initiatives between India and the United States of America.

Mission

- Act as a catalyst to promote long-term scientific collaborations between India and the U.S. through partnership amongst individual scientists, scientific institutions and the scientific community at large.
- Establish platforms and mechanisms to connect the S&T eco-systems of both the countries to act as a fertile ground to foster individual and institutional partnerships in a natural and sustainable manner.

Objectives

- Create awareness through exchange dissemination of Information and Opportunities in S&T cooperation.
- Capitalize and build on the scientific and technological synergy leading to long term partnership on shared values.
- Support exciting program portfolio that leads to sustainable interactions and strengthens strategic partnerships.
- Nurture contacts between young and mid-career scientists to develop mutual trust, foster excellence and explore new frontiers.
- Encourage public-private partnership to foster elements of Innovation, Application and Enterprise.

IUSSTF Program Portfolio

(Classified by Verticals)

I. Scientific Networks

- Bilateral Workshops/Training Programs/Symposia
- Indo-U.S. Virtual Networked Centres

II. Innovation and Entrepreneurship

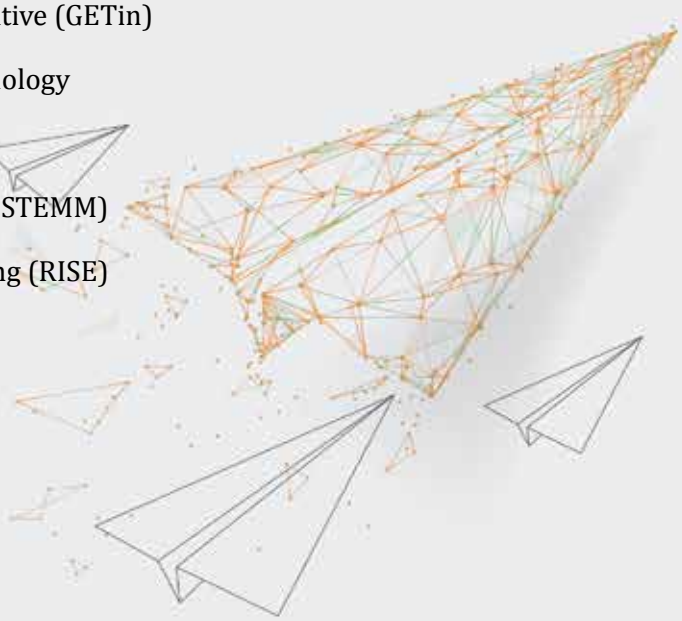
- U.S.-India Science and Technology Endowment Fund (USISTEF)

III. Research and Development

- Indo-U.S. Joint Clean Energy Research and Development Centre (JCERDC)
- PACEsetter Fund
- Real Time River Water and Air Quality Monitoring (WAQM)

IV. Visitations and Fellowships

- Bhaskara Advanced Solar Energy (BASE) Fellowships
- Bioenergy-Awards for Cutting Edge Research (B-ACER)
- Building Energy Efficiency Higher & Advanced Network (BHAVAN) Fellowships
- Water Advanced Research and Innovation (WARI) Fellowships
- Genome Engineering/Editing Technology Initiative (GETin)
- ASM-IUSSTF Indo-U.S. Professorship in Microbiology
- IUSSTF–American Physical Society Fellowships
- Indo-U.S. Fellowship for Women in STEMM (WISTEMM)
- Research Internships in Science and Engineering (RISE)
- Khorana Program for Scholars
- IUSSTF-Viterbi Program



IUSSTF Program Portfolio

(Classified by Nature of Support)

I. IUSSTF Core

- Bilateral Workshops/Training Programs/Symposia
- Indo-U.S. Virtual Networked Centres
- IUSSTF-Viterbi Program
- IUSSTF- APS Fellowships
- ASM-IUSSTF Professorship
- Research Internships in Science and Engineering

II. U.S.-India Science and Technology Endowment Fund (USISTEF)

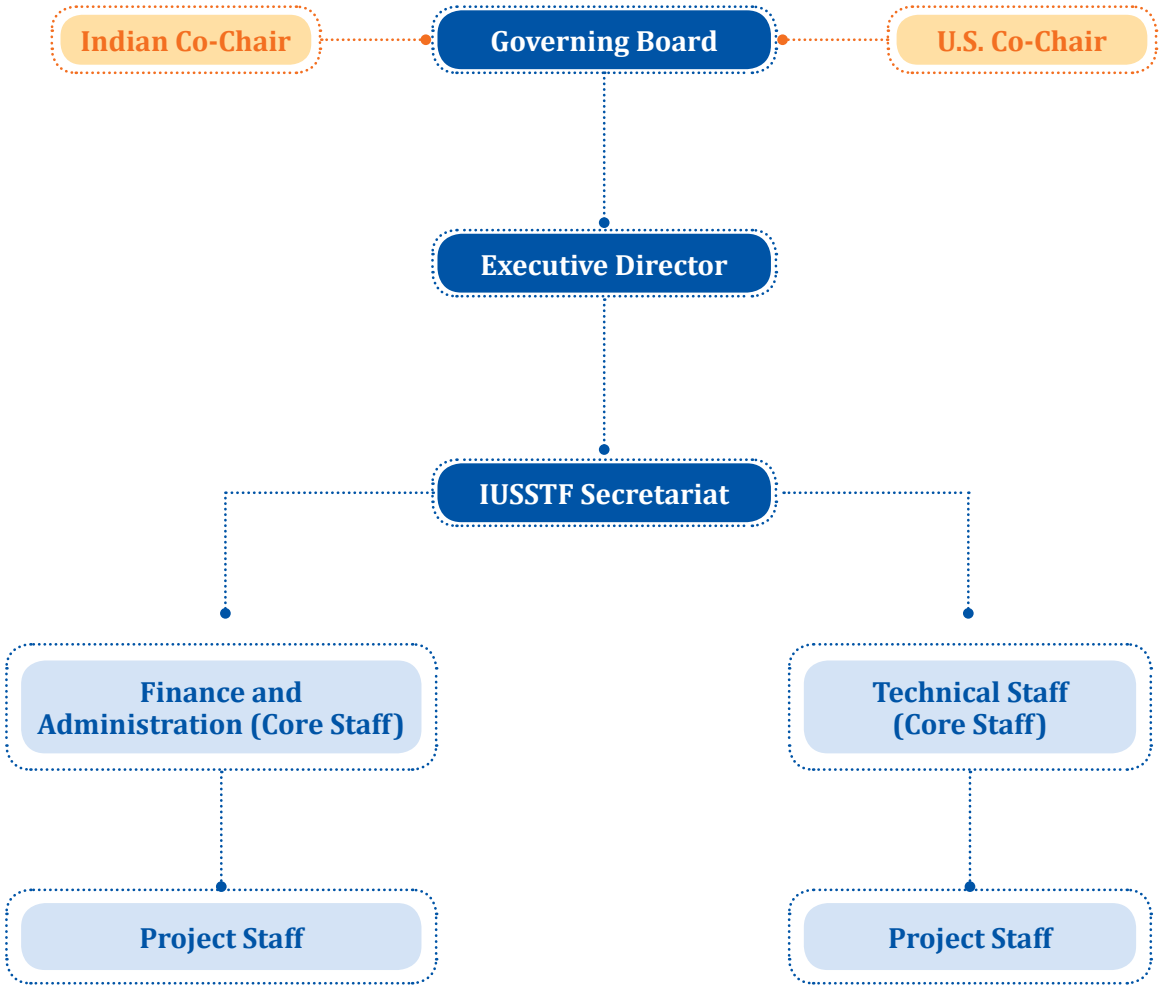
III. Extra Mural Programs- EMPs

(Supported by External Agencies/ Industry)

- Indo U.S. Joint Clean Energy Research and Development Centre
- PACEsetter Fund
- Real Time River Water and Air Quality Monitoring
- Bhaskara Advanced Solar Energy Fellowship
- Bioenergy-Awards for Cutting Edge Research
- Building Energy Efficiency Higher & Advanced Network Fellowships
- Genome Engineering/Editing Technology Initiative
- Indo-U.S. Fellowship for Women in STEMM
- Water Advanced Research and Innovation Fellowship
- Khorana Program for Scholars

Governance Structure

IUSSTF Organizational Chart



Administrative Mechanism

- Autonomous
- Bilateral
- Non-Governmental
- Not for Profit Society

Funding Source

- Annual Interest from U.S. Endowment Fund with matching contribution from DST, Govt. of India
- Freedom to Secure Private and Other Funding

IUSSTF Governing Board

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National Association of
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Companies (NASSCOM)

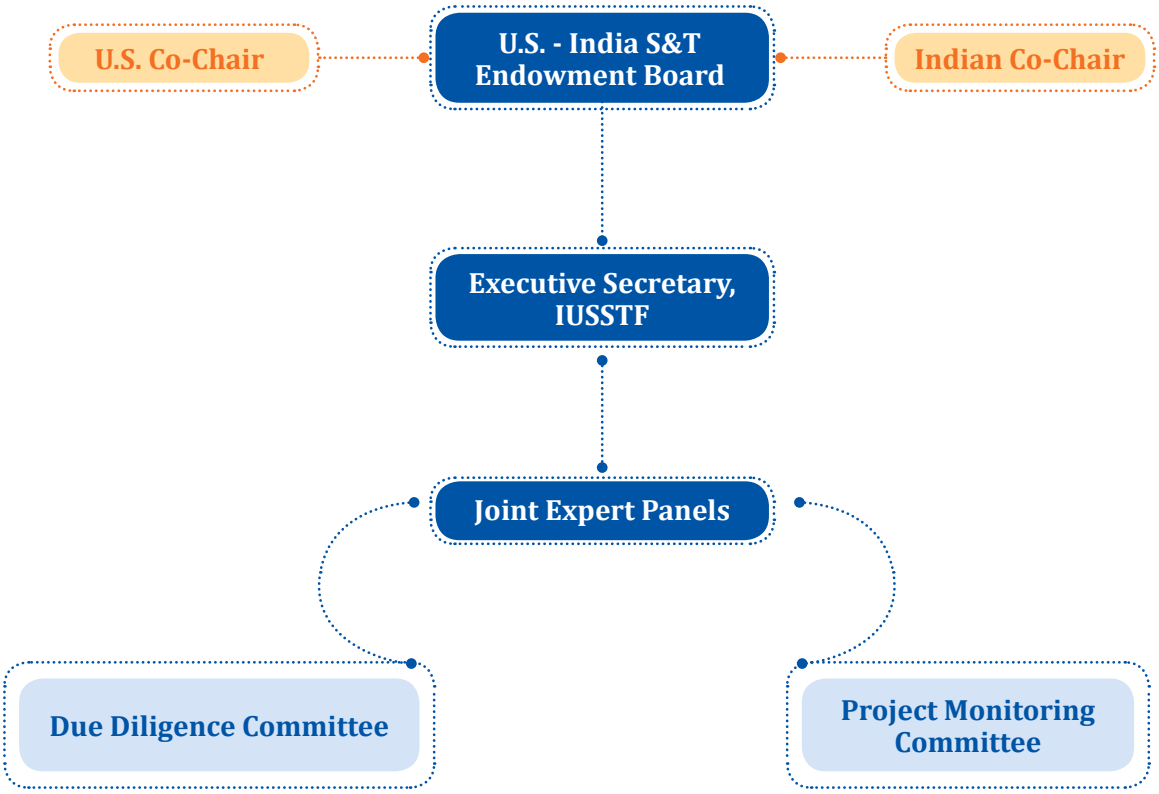
Aseem Ansari

Winstep Forward

Amita Gupta

Johns Hopkins
University

Functional Structure for USISTEF



USISTEF
UNITED STATES - INDIA SCIENCE & TECHNOLOGY ENDOWMENT FUND

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Programme Management Unit (PMU) supported by DBT-BIRAC-BMGF-Wellcome Trust

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National Institute of Technology, Tiruchirappalli

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Senior Personal Secretary

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Year at a Glance

Highlights of the Year

Strategic Initiatives

- March 2021 saw the launch of IUSSTF's **U.S. India Artificial Intelligence Initiative (USIAI)** - a platform for key stakeholders to discuss opportunities and barriers for bilateral AI R&D collaboration, share ideas for developing an AI workforce, and recommend modes and mechanisms for catalysing partnerships between the India and the United States.
- To support the global efforts of the medical and scientific community in battling the COVID-19 pandemic, IUSSTF announced two calls for proposals to catalyse partnerships between Indian and U.S. researchers and entrepreneurs: **(1) COVID-19 Indo-U.S. Virtual Networks** to enable teams of Indian and U.S. scientists and engineers currently engaged in COVID-related research to carry out joint research activities through a virtual mechanism, leveraging existing infrastructure; and, **(2) COVID-19 Ignition Grants** that support, through the United States–India Science & Technology Endowment Fund (USISTEF), promising joint U.S.-India S&T based entrepreneurial initiatives providing innovative, out-of-the-box solutions to COVID-19 challenges.

Section I:
Scientific Networks

Scientific Networks

IUSSTF-funded collaborations provide a platform for young and early-career scientists to interact and network with their seniors and counterparts, who could potentially become both mentors and collaborators. Building scientific networks not only helps share expertise thereby doubling the value of the effort; but also many times leads to the generation of completely novel ideas.

IUSSTF promotes such networks to foster long-term collaborations between the scientific communities of India and the United States through two separate yet complimentary programs. While **"Bilateral Workshops"** are expected to act as an instant connect and point of formal initiation; **"Virtual Networked Centers"** provide a formal mechanism to support specific collaborations for an extended period of time.

Bilateral Workshops/Training Programs

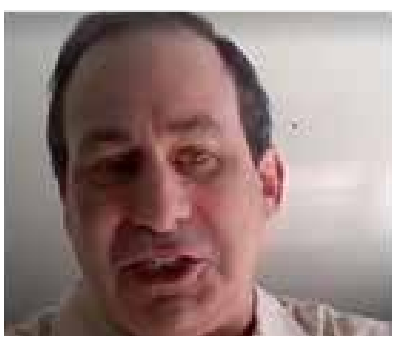
Bilateral Workshops are targeted to promote interactions between Indian and American scientists and engineers from academia, laboratories and industry with the explicit aim to develop sustained linkages. Proposals are peer-reviewed both in India and the United States. The review parameters include novelty of topic, mutual benefits to India and the U.S., background of workshop coordinators and participants, potential for developing new and sustained bilateral linkages, student participation, etc.

In light of the COVID-19 crisis in the period 2020-21, IUSSTF did not solicit new applications for Bilateral Workshops/Symposia/Training Programs. However, Dr. Jayasri Das Sarma (IISER Kolkata) and Dr. Kenneth Shindler (University of Pennsylvania) organized a virtual Bilateral Indo-U.S. **Webinar on COVID-19 Biology** (August 16-19, 2020) as a follow-up of an earlier bilateral Indo-U.S. symposium held in 2019 entitled "New insights in the inflammation, immunity and pathobiology of Diseases". This special webinar was organised under the banner of IUSSTF on the research and educational dimensions of the Corona Virus Disease 2019 pandemic. The rationale behind the workshop was the mounting number of human coronaviruses (H-CoV) that have emerged from zoonotic transmission in recent decades that demand design of therapies with the potential to treat standard features of common coronavirus pathogenesis, including COVID-19. This webinar provided a platform to learn from experts working in areas such as *Emergence of Human β-Coronaviruses with particular emphasis on SARS- CoV2 Origins, Evolution & Modelling; Clinical and Molecular Virology of SARS-CoV-2; SARS-CoV-2 Pathogenesis and Host response/Antivirals; and, SARS-CoV-2 Pathogenesis: Insights from other β-Coronaviruses tested on different experimental models.*

The webinar hosted distinguished speakers who have been working on coronavirus for decades as well as those who have recently joined the field to help battle this disease. The sessions were attended by more than 1200 participants from all over the world.





Virtual Networked Centres

The aim of **Virtual Networked Centers** is to enable Indian and American scientists to carry out joint research activities by leveraging already existing infrastructure and funding available with the partners on both sides through a linkage established by a virtual mechanism that provides for seamless connectivity and exchange of faculty/ scientists and students from both sides. These centers are supported under two categories:

- **Knowledge R & D Networked Centres:**
  - Partners: R&D labs and academia partnership (2+2)
  - Provide opportunities for integrating research and education
- **Public-Private Networked Centers:**
  - Partners: Academia/ R&D lab - Industry partnership (2+2)
  - Promote pre-commercial R & D with application potential

Due to the COVID-19 pandemic, the regular call for Virtual Networks was placed on hold for the year 2020-21.

Special Call: Indo-U.S. Virtual Networks for COVID-19

In response to the pandemic, IUSSTF announced a Special Call for Proposals for Indo-U.S. Virtual Networks for COVID-19 in April 2020. The intent was to encourage proposals that convincingly demonstrate the benefits and value of the Indo-U.S. partnership to advance research and address critical challenges related to COVID-19. Following a rigorous binational peer-review process, IUSSTF announced awards to eight teams on 17 August 2020. These teams, representing leading researchers from top Indian and U.S. Institutions are now pursuing cutting-edge research in areas that include studies on pathogenesis and disease management in COVID-19, antiviral coatings, immune modulation, tracking SARS CoV-2 in wastewater, disease detection mechanisms, reverse genetics strategies, and drug repurposing.

Virtual Networks for COVID-19 Awardees

1. **Real time high-throughput cost-effective sequencing platform for 2019-nCOV detection and genotyping**

Rajesh Pandey

CSIR-Institute of Genomics and Integrative Biology, Delhi

Sarath Chandra Janga

Indiana University, Indianapolis

Due to the rapidly evolving nature of coronaviruses, their identification has become increasingly challenging. Hence, there is an urgent need to generate new diagnostic tests that combine scale, speed, sensitivity and generation of data that can be used to inform surveillance, public health strategy, and vaccine design. The team proposes to combine an efficient, novel and high-throughput RNA isolation method, accompanied with pooled and high-throughput barcoded Nanopore sequencing of swab samples and develop automated computational pipelines to facilitate detection of SARS-CoV2 from samples. This will result in a real-time scalable diagnostic platform for simultaneous detection and mapping of specific strains using a cost-effective benchtop sequencer facilitating rapid diagnostics for front line workers.

2. Electron microscopy study to explore the effectiveness of HCQS on COVID-19 disease from *ex vivo* patient samples

Subhash Chandra Yadav
All India Institute of Medical Science, New Delhi

Wah Chiu
Stanford University, Stanford

The team has proposed to investigate the role of Hydroxychloroquine (HCQS) by exploring the significant alteration in cellular infectivity and multiplication of SARS-CoV-2 at different stages of the COVID-19 disease. The Indian group at AIIMS, New Delhi would be responsible for patient samples, RT-PCR (Real-time polymerase chain reaction) quantification, 3D-confocal, Transmission Electron Microscope (TEM) and IEM imaging for cellular interaction, internalization, multiplication, and release. The exploration of molecular level interaction of coronavirus and cellular receptors would be carried out at Stanford University by cryo-EM and cryo-ET coupled with image reconstruction. The collaborative work may provide the complete overview of the effect of HCQS in the control of SARS-CoV-2 from *ex vivo* patient samples.

3. Lymphopenia in COVID-19: Implication in pathogenesis and disease management

Jyotsna Agarwal
Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow

Ankita Garg
University of Georgia, Athens

Management of COVID-19 patients is a challenge for physicians since pathogenesis remains less ill-defined. Significance of the proposed research is in combining clinical and mechanistic/translational approach to understand factors responsible for immune cell death. Clinical parameters of COVID-19 patients will be assessed at COVID-19 hospital and diagnostic BSL-2 laboratory in Ram Manohar Lohia Institute of Medical Sciences, Lucknow; whereas mechanistic/translational work will be undertaken in BSL-3 lab at the University of Georgia, Athens.

4. Development of antiviral coatings to prevent the transmission of SARS-CoV-2 viruses

Jayanta Haldar
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

Shiv Pillai
Ragon Institute of MGH, MIT and Harvard, Cambridge

The SARS-CoV-2 pandemic has once again highlighted the dire need for antimicrobial surfaces to break the chain of transmission of droplet-borne viral diseases. However, the global market is currently devoid of antimicrobial coating materials applicable to surfaces commonly encountered in everyday life. The

team's goal is to develop a one-step, permanent, robust, antiviral coating for daily encountered surfaces such as door-handles, railings, seat covers, switches, credit cards, ID cards and even currency notes. Spray or brush coating of these compounds from their organo-solution on polyethylene or polypropylene-based transparent flexible sheets can render them antiviral. A wide range of surfaces (polyethylene, polypropylene, polyurethane, metallic surfaces etc.) coated with these compounds will be investigated against SARS-CoV-2.

5. Mitigating COVID-19 infection and progression via innate immune modulation

Suparno Chakrabarti
Dharamshila Narayana Superspeciality Hospital, New Delhi

Sanjay V. Malhotra
Oregon Health & Science University, Portland

Mycidac-C (Mw), a potent immune stimulant used for cancer treatment in India, has demonstrated significant inhibition of cytokine storm in gram negative sepsis with ~2X greater survival. With similarities of disease pathologies in cancer and COVID-19, the team hypothesize that Mw treatment will decrease COVID infection and progression. This hypothesis will be established through the two specific aims of the study, i.e. (1) Dose-exposure effect of Mw mechanism against COVID, and (ii) Therapeutic index of Mw treatment in COVID *in vivo*.

6. Occurrence and persistence of SARS-CoV-2 (COVID-19) along with known biological indicators in waste waters of Mumbai city

Sandhya Shrivastava
Bhavan's Research Center (Microbiology), Mumbai

Joan Rose
Michigan State University, East Lansing

Understanding the fate of SARS- CoV-2 through the different stages of wastewater treatment and the safety of treated waters to be discharged in the environment is required from epidemiological perspective. The team aims to study developing competency and methodology for sampling, effective recovery and detection of SARS-CoV-2 to: 1) Understand its incidence and persistence in Mumbai City wastewaters; 2) Evaluate RNA bacteriophages as a suitable biological indicator for SARS-CoV-2 in surveillance studies and assessment of wastewater treatment efficacy; and 3) Assess wastewater associated virus data as a reliable epidemiological tool to link the presence of virus with community infection and public health. Successful evaluations would generate knowledge based insights or guidelines for wastewater surveillance.

7. Leveraging reverse genetics strategies to study structure-function interplay of virus host attachment spike protein to design therapies for COVID-19

Jayasri Das Sarma

Indian Institute of Science Education and Research Kolkata, Nadia

Maria Nagel

University of Colorado School of Medicine, Aurora

This project is led by Dr. Jayasri Das Sarma in India and Dr. Maria Nagel in the US, supported by a team of seven co-investigators with long-standing collaborations in coronavirus research. Coronavirus spike gene that mediates infectivity and RdRp gene that regulates viral replication are the key regulators of SARS-CoV2 infectivity. This team's strategy combines novel murine coronavirus expressing the SARS-CoV-2 spike and RdRp genes coupled with humanized ACE-2 expressing mice to screen pharmacologic agents [e.g. *Azadirachta indica* (Neem) extract] in a system that is translatable to clinical settings. They will assess the inflammatory effects of COVID-19 on lung, liver, kidney, and Central Nervous System.

8. Establishment of an Indo-U.S. Molecular Biomarker Knowledge Network for COVID-19

Shantikumar V. Nair

Amrita Centre for Nanosciences and Molecular Medicine, Kochi

Mohit Jain

University of California, San Diego, La Jolla

This teams' focus is on discovery of molecular biomarkers of COVID-19 with respect to internal and external exposure factors called exposomes that can provide early warning for COVID-19 susceptibility and severity, as well as targets for therapeutic modalities. The approach includes: 1) Biochemical profiling of patients for molecules such as, inflammatory markers, cytokines, proteins, metabolites and toxins using mass spectrometry; 2) Clinical evaluation of the patients to quantify severity levels; 3) Derivation of data-driven biomarker-suggestive correlation between the molecules and severity quantization; 4) Integration into EMR Hospital Information Systems for inclusion into standardized clinical patient consultation protocols; and 5) Building capacity in India for robotic arm mass-spectrometry for ultra-high throughput testing of Bio-Monitoring microsamples.

Section II:
Strategic Initiatives

IUSSTF's U.S. - India Artificial Intelligence (USIAI) Initiative

The promise and potential of Artificial Intelligence (AI) to disrupt and transform society is driving the new Industrial Revolution. From deep learning algorithms for cancer diagnosis, application of machine learning to discover new materials, the use of 3D printers in advanced manufacturing, to intelligent systems with cognition and decision-making abilities, AI tools and technologies are enabling breakthroughs in many fields of science and engineering, leveraging these scientific breakthroughs to enable progress on pressing societal challenges, and transforming several sectors of the economy.

The United States and India are making important strides in advancing artificial intelligence, prioritizing public and private research and development (R&D) investments, addressing the critical challenge of developing a diverse AI workforce, and highlighting the importance of partnerships. **IUSSTF's U.S. – India Artificial Intelligence (USIAI) Initiative** provides a unique opportunity for the world's two largest democracies to strengthen their strategic partnership by focusing on AI cooperation in critical areas that are priorities for both countries. USIAI serves as a platform to discuss opportunities and barriers for bilateral AI R&D collaboration, share ideas for developing an AI savvy workforce, and recommend modes and mechanisms for catalyzing partnerships to facilitate these technologies for strengthening U.S.-India cooperation.

As part of its activities, USIAI will conduct a series of roundtables and workshops to gather input from different stakeholder communities and prepare white papers that identify technical, research, infrastructure, and workforce opportunities and challenges, and domain-specific opportunities for R&D in healthcare, smart cities, materials, agriculture, energy, and manufacturing.

A Curtain Raiser event for USIAI was held on March 17th, 2021, that featured inaugural talks by **Professor Ashutosh Sharma**, Secretary, Department of Science and Technology, Government of India (Indian Co-Chair) and **Dr. Jonathan Margolis**, Deputy Assistant Secretary for Science, Space and Health, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State (U.S. Co-Chair). This was followed by keynote lectures from **Dr. Sethuraman "Panch" Panchanathan**, Director, National Science Foundation (NSF) and **Mr. Kris Gopalakrishnan**, Chairman of Axilor Ventures and one of the founders of Infosys. The event concluded with an engrossing panel discussion that included members of USIAI's Steering Committee deliberating on the possibilities, challenges, and scope of AI technologies to bring about breakthrough solutions in a variety of sectors. The panelists also discussed AI security and privacy concerns, as well as the challenges of building an AI-enabled workforce.

To further the goals of USIAI and to leverage expertise across different stakeholder communities, IUSSTF reached out to organizations that have complementary research interests and were willing to collaborate in the field of Artificial Intelligence. IUSSTF has developed knowledge partnerships (KP) with organizations with similar goals and objectives. Memorandums of Understanding (MoUs) have been signed with organizations to collaborate in specific thematic areas. These include organizations such as *Wadhwani AI* (for AI in Agriculture), *itihaasa Research and Digital* (for AI workforce development), and the *U.S.-India Strategic Partnership Forum* (USISPF; for AI in Healthcare).

USIAI CURTAIN RAISER: KEYNOTE SPEAKERS

Kris Gopalakrishnan
Chairman, Axilor Ventures, Bengaluru

Seturaman Panchanathan
Director, National Science Foundation, Alexandria

USIAI CURTAIN RAISER: PANELISTS

Anurag Agarwal
Director, Institute of Genomic and integrative Biology, New Delhi

Padmanabhan Anandan
Ex-CEO, Wadhwani Institute for Artifical Intelligence, Mumbai

Aseem Ansari
Chair, Chemical Biology and Therapeutics, St Jude Children's Research Hospital, Memphis

Jim Kurose
Distinguished University Professor, College of Infomation and Computer Science, University of Massachusetts, Amherst

Jitendra Malik
Professor, Electrical Engineering and Computer Sciences University of Califonia, Berkeley

R. Ramanan
Director, Atal Innovation Mission (AIM), NITI Aayog, New Del

Elizabeth Urbanas
Deputy Assistant Secretary for Asia and the Americas, U.S. Department of Energy, Washington D.C.

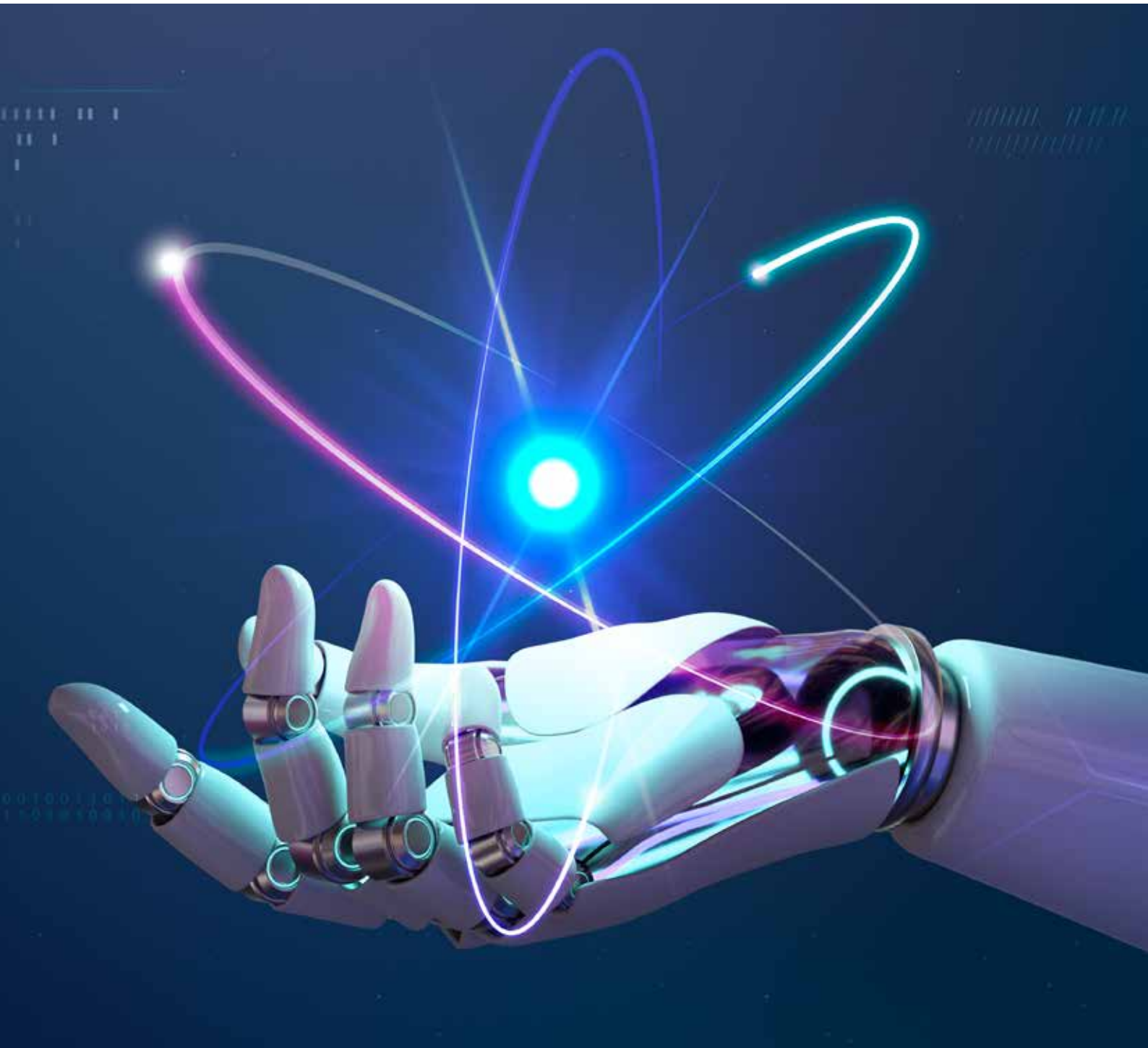
Sandeep Verma
Secretary,
Science and Engineering Research Board, New Delhi

Section III:
Innovation and Entrepreneurship

Innovation and Entrepreneurship

Innovation supported by a vibrant entrepreneurial ecosystem will be the key to success in this era of rapid technological evolution. IUSSTF's innovation and entrepreneurship engagements are S&T driven and have the capability and potential to benefit not only our two countries, but the world at large.

IUSSTF provides grant-in-aid funding support to startups under the **United States India Science and Technology Endowment Fund (USISTEF)**. This program enables bilateral teams from India and the United States to translate S&T driven innovations with a tangible societal impact into distinct market opportunities.



United States–India Science & Technology Endowment Fund (USISTEF)

The governments of the United States of America (through the Department of State) and India (through the Department of Science & Technology) established the **U.S. India Science and Technology Endowment Fund (USISTEF)** for the promotion of joint activities that would lead to innovation and entrepreneurship through the application of science and technology.

Through a highly competitive process, USISTEF selects and supports financially promising Joint U.S.-India entrepreneurial initiatives on co-developing products or technologies that are beyond the ideation stage, high on societal impact and have significant potential to commercialize within 2-3 years. The projects are organized into two broad categories, namely "Empowering Citizens (EC)" and "Healthy Individuals (HI)". USISTEF has supported 38 joint U.S. India Entrepreneurial Projects through 10 calls.

Highlights

- In response to the **10th Call** for Proposals, USISTEF received 256 applications – 134 in the Healthy Individuals (HI) category and 122 in the Empowering Citizens (EC) category. After a multi-tier review, the Joint Experts Panel (JEP) shortlisted 13 projects (6 in EC and 7 in HI) for subsequent site-visits and Financial Due-Diligence. The Due-Diligence Committee met via videoconference on 31st August 2020 & 10th September 2020 and reviewed the 13 shortlisted projects following which a formal recommendation was made to the Board.

- The **21st Meeting** of the **U.S.-India Science and Technology Endowment Board** (USISTEB) was held on 30th September, 2020 to finalize award recommendations for the **10th Call of the USISTEF Program**, under the Co-Chairmanship of **Mr. Sanjeev K. Varshney**, Adviser & Head, International Bilateral Cooperation, Department of Science & Technology, Govt. of India (Indian Co-Chair) and **Mr. John Speaks**, Acting Minister Counselor for Energy, Environment, Science, and Technology, U.S. Embassy, New Delhi (Acting U. S. Co-Chair). ED, IUSSTF presented an overview of the Endowment Fund's activities over the past year. The Board also deliberated upon strategic and new models of collaboration going forward. As part of its deliberations, the Board recommended the following five projects for support under the 10th Call:

S. No.	Project Title	Indian PI	U.S. PI
1.	Empowering Energy Frugal, Inexpensive Waste-Less Food Storage and Transport (for Seven Lakh Indian Villages)	**Anurag Agarwal** New Leaf Dynamic Technologies Pvt. Ltd., New Delhi	**Srinivas Garimella** Georgia Institute of Technology, Atlanta
2.	TranscribeGlass: Affordable Heads-Up Real-time Captioning Device for the Deaf and Hard-of-Hearing	**Madhav Lavakare** TinkerTech Labs Private Limited, New Delhi	**Kyle Keane** Massachusetts Institute of Technology, Cambridge

S. No.	Project Title	Indian PI	U.S. PI
3.	An Affordable Ambulatory 24-Channel Clinical Grade Robotic Video Electroencephalography (VEEG) Solution for the Diagnosis and Monitoring of Neurological & Mental Health Conditions	**Raja Aditya Kadambi** Mocxa Health Private Limited, Bengaluru	**Simon Griffin** Lifelines Neuro Company LLC, Louisville
4.	Co-Design, Evaluation And Technology Transfer of an Adjustable, Affordable and Transportable Paediatric Postural Support Wheelchair for India	**Soikat Ghosh Moulic** Mobility India, Bengaluru	**Anand Mhatre** University of Pittsburgh Pittsburgh
5.	An Affordable, Non-Invasive Multiplexed Platform to Rapidly Detect High Risk Oncogenic HPV Strains in Self-Collected Samples (Point of Care, Field Deployable, Highly Multiplex, Genital/Urinary Samples)	**Nikhil Phadke** GenePath Diagnostics India Pvt. Ltd, Pune	**Steven Benner** Firebird Biomolecular Sciences, LLC, Alachua

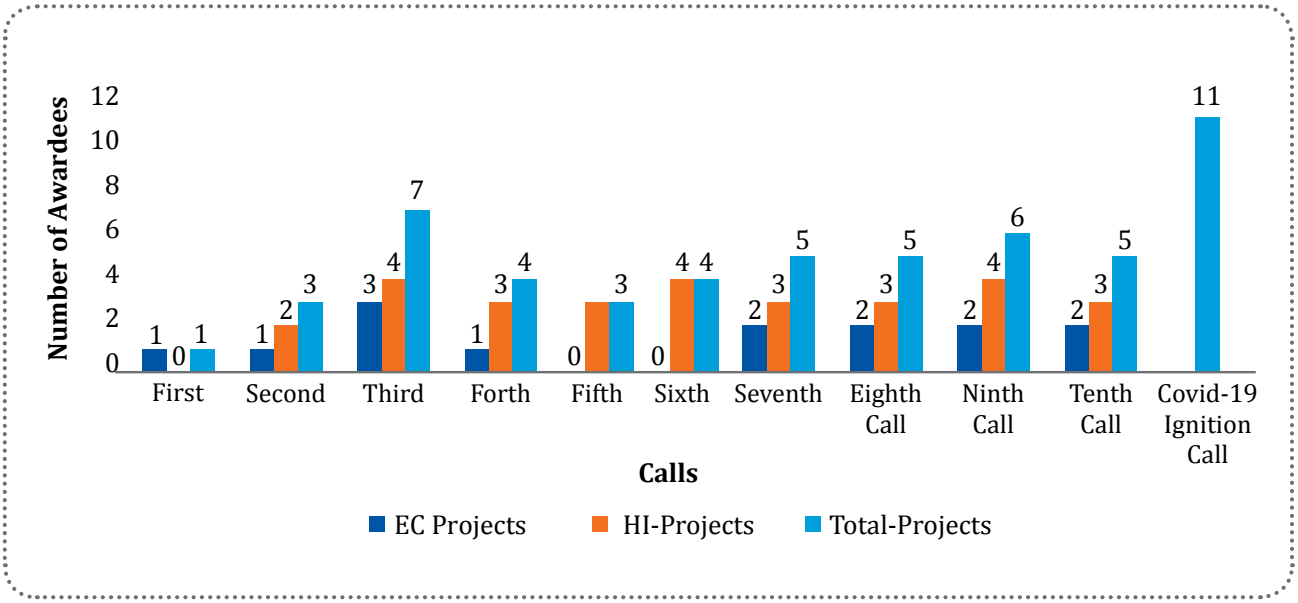
- Three Project Monitoring Committee (PMC) meetings were held on 14th May 2020, 27th May, 2020 and 29th June, 2020 via videoconference to review the progress of eleven USISTEF Projects under previous calls. The list of projects reviewed during the meeting are listed in ***Annexure I***
- Three projects awarded during the previous calls have also been successfully closed in FY 2020-21 ***(Annexure II)***.

Overall Status Across all Calls

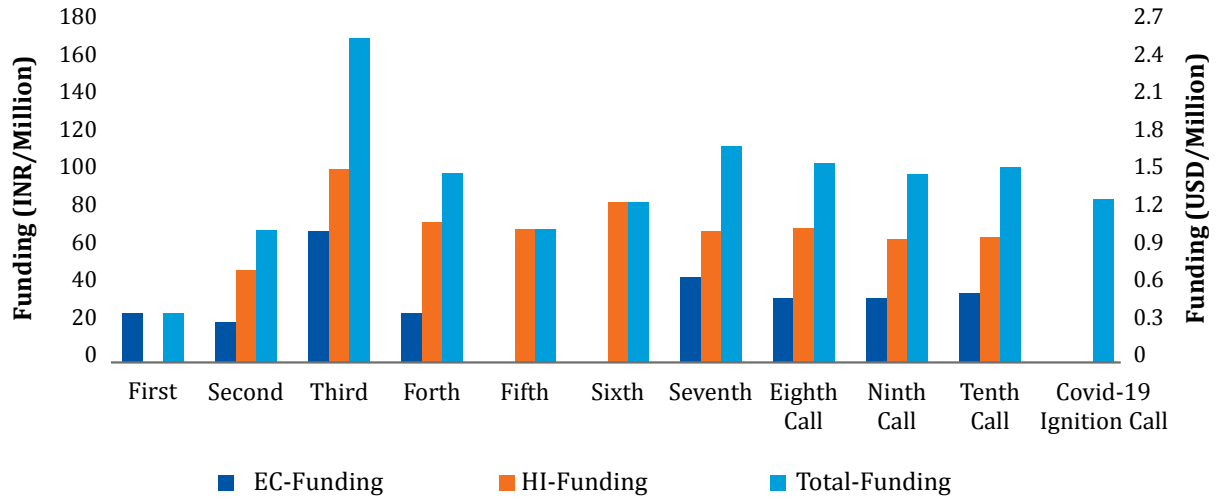
Calls	EC			HI			Total		
	Projects	Funding		Projects	Funding		Projects	Funding	
		(INR/ Million)	(USD/ Million)*		(INR/ Million)	(USD/ Million)*		(INR/ Million)	(USD/ Million)*
First	1	24.92	0.34	0	0	0.00	1	24.92	0.34
Second	1	20.32	0.27	2	46.51	0.63	3	66.83	0.90
Third	3	66.34	0.90	4	97.72	1.32	7	164.06	2.22
Forth	1	24.8	0.34	3	70.96	0.96	4	95.76	1.29
Fifth	0	0	0.00	3	67.31	0.91	3	67.31	0.91
Sixth	0	0	0.00	4	81.28	1.10	4	81.28	1.10
Seventh	2	43.3	0.59	3	66.23	0.90	5	109.53	1.48
Eighth	2	32.7	0.44	3	67.9	0.92	5	100.60	1.36
Ninth	2	32.5	0.44	4	62.5	0.84	6	95	1.28
Tenth	2	35.10	0.47	3	63.40	0.86	5	98.50	1.33
Covid 19 Call	-	-	0.00	-	-	0.00	11	82.75	1.12
Total	**14**	**279.98**	**3.78**	**29**	**623.81**	**8.43**	**54**	**986.54**	**13.33**

**1USD= 74 INR*

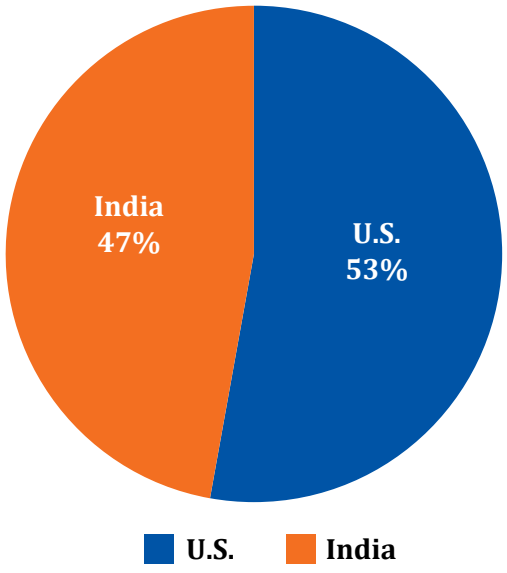
Award Status - In Numbers

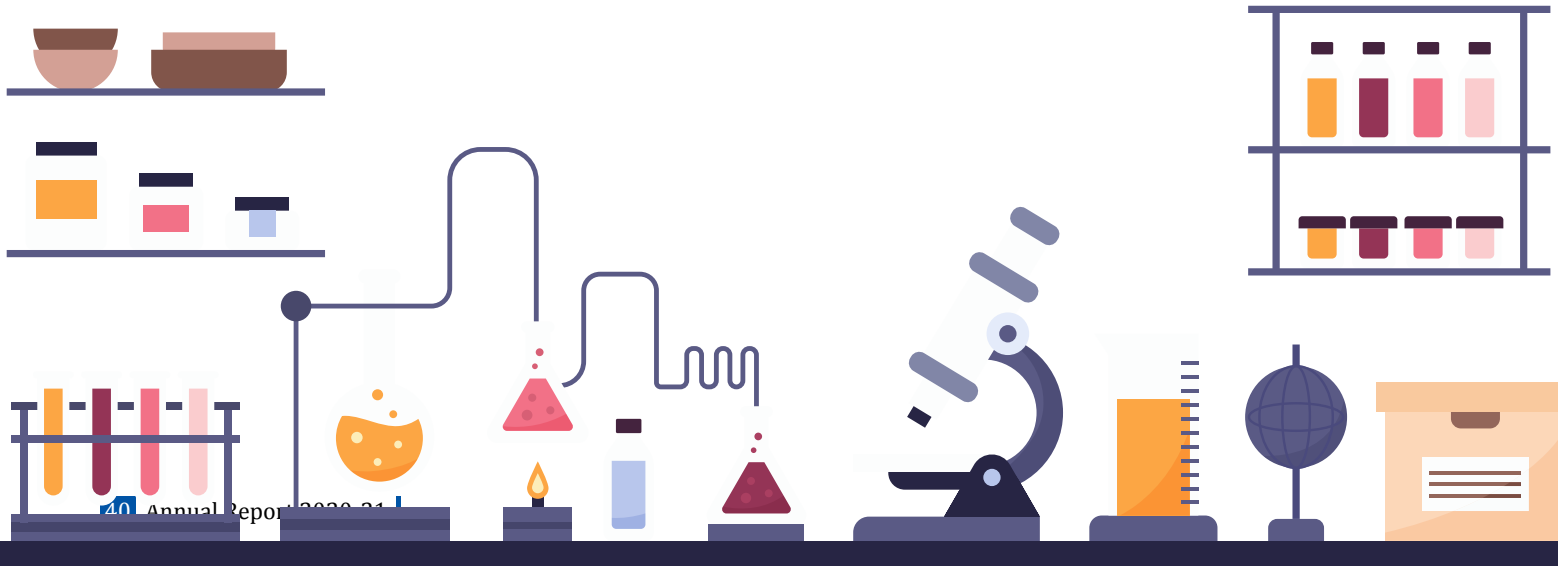


Award Status - Funding

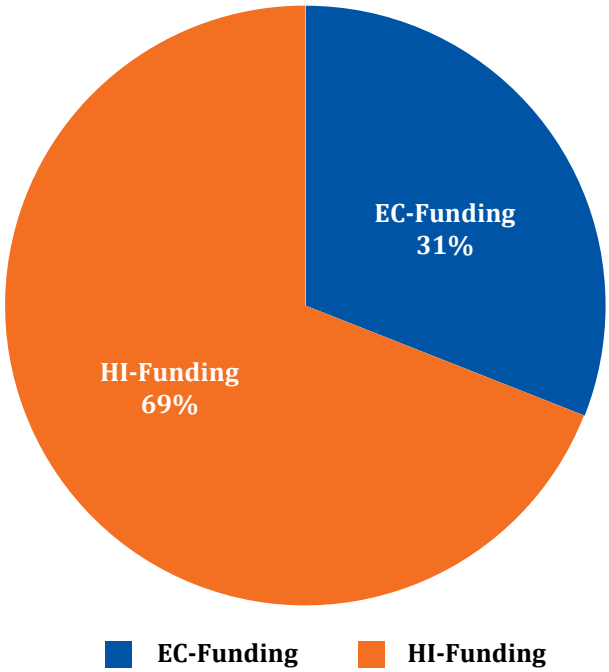


Overall Fund Distrubution (Country-wise)

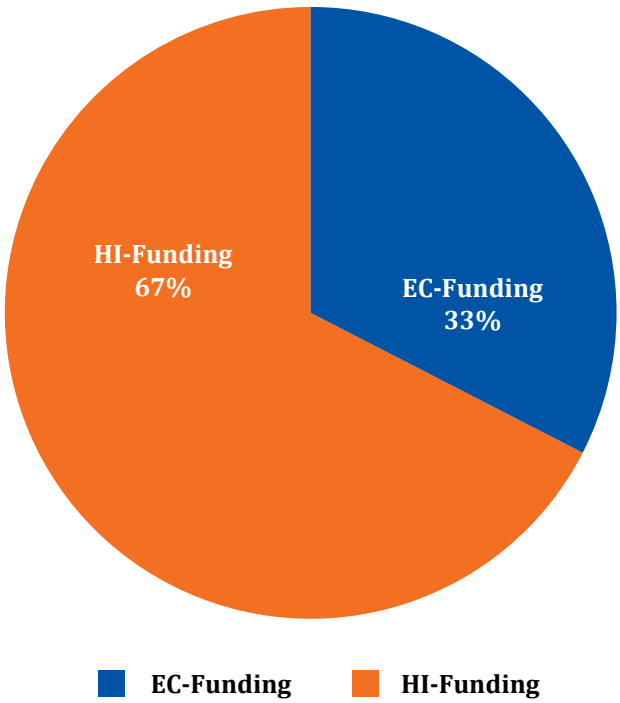




Overall Fund Distrubution (Area-wise)



Overall Distribution in Numbers (Area wise)



EC - Empowering Citizens
HI - Healthy Individuals

Special Call: COVID-19 Ignition Grants

As countries battle the COVID-19 pandemic, innovations in Science, Engineering, and Technology will play a critical role in finding solutions to this global challenge. For example, new vaccines, devices, diagnostic tools, information systems, and strategies will help countries manage and deploy resources to combat this pandemic. In keeping with its mission and vision, USISTEF announced a call for proposals under the category of **COVID-19 Ignition Grants** in April 2020. The intent was to support promising joint U.S.-India entrepreneurial initiatives that address the development and implementation of new technologies, tools, and systems to address COVID-19 related challenges, including monitoring, diagnosis, health and safety, public outreach, information, and communications.

Proposals were solicited in two categories - **Ignition Stage-I** (for early-stage creative ideas to develop a proof-of-concept and/or build a prototype) and **Ignition Stage-II** (for supporting teams with a workable, validated prototype and/or with the ability to repurpose existing innovative solutions to meet the COVID-19 challenge). In response to this call, IUSSTF received a total of 452 applications: 257 in the Ignition Stage-I and 195 in the Ignition Stage-II category.

After a rigorous binational review process, a **Special Meeting** of the **U.S.-India Science and Technology Endowment Board** (USISTEB) was held on 31st July, 2020 to finalize award recommendations for the **COVID-19 Ignition Grants Program**, under the Co-Chairmanship of **Dr. Naveen Vasishta**, Director/ Scientist ' F', NEB Division, Department of Science & Technology, Govt. of India (Acting Indian Co-Chair) and **Ms. Isabella Detwiler**, Acting Minister Counselor, Economic, Environment, Science & Technology Affairs, U.S. Embassy, New Delhi (Acting U.S. Co-Chair). The Board recommended support to 11 bilateral teams, proposing out-of-the-box, innovative ideas that address the COVID-19 challenge. These teams will be working on solutions that include novel early diagnostic tests, antiviral therapy, drug repurposing, ventilator research, disinfection machines, and sensor-based symptom tracking.

Ignition Stage I Awardees

1. Development of Antisense Morpholino (PMO)-based antiviral therapy against Coronavirus

Surajit Sinha
Indian Association for the Cultivation of Science, Jadavpur

Yanjin Zhang
University of Maryland, College Park

Morpholino testing against other viruses has demonstrated a high efficiency in inhibiting viral replication. The project aims to develop antisense morpholino oligomer-based therapies against SARS-CoV-2. The genomic RNA of SARS-CoV-2, specifically the conserved regions, will be targeted to inhibit the viral replication. Antisense morpholinos will be synthesized using solid support synthesis method and will be conjugated with a delivery vehicle called internal guanidnium cellular transporter (IGT) for the effective delivery of the oligomer. The lead Indian partner has developed a technology for the synthesis

and delivery method of morpholino, while the U.S. lead will bring in experience in PMO testing against several types of viruses. The Indian Industry partner will work to scale-up morpholino production for future commercialization.

2. Development and validation of a CRISPR-based rapid and affordable kit for early diagnosis of COVID-19

Suresh Chandra Singh
Patanjali Pharma Pvt. Ltd., Mumbai

Piyush K Jain
University of Florida, Gainesville

The team proposes to develop a prototype to detect SARS-CoV-2 by combining the loop-mediated isothermal amplification with an engineered CRISPR/Cas12a technology to achieve detection of SARS-CoV-2 genomic RNA with high specificity and sensitivity. By combining with a lateral flow assay, the entire workflow can be conducted using an inexpensive heat block without requiring large capital equipment. The overall goal of this collaboration is to provide an affordable and accurate diagnosis for COVID-19.

3. Development of a diagnostic test using Multiplex in Solution Protein Array (MISPA) for distinguishing COVID-19 infection from other viral infections

Sanjeeva Srivastava
Indian Institute of Technology-Bombay

Joshua Labaer
Arizona State University, Tempe

Many types of serology assays have been developed for SARS-CoV-2. However, the one-antigen-one-patient-at-a-time approaches provide very limited information and are slow, time consuming, and low throughput. To this end, the team is working on a high-throughput multiplex in solution serological assay (MISPA) that allows measuring antibody responses against the entire proteome of SARS-CoV-2 for many patients in a single test. With an expanded dynamic range and increased signal-to-noise ratio, it is expected that MISPA assay would detect both weak and strong antibody responses. The team will probe the entire proteome of SARS-CoV-2 to understand the comprehensive antibody profile on many patients in a high-throughput manner.

4. Development and screening of drug or zinc nanoparticle conjugated synthetic nano-bodies ("Sybodies") to neutralize SARS-CoV-2 virus that causes COVID-19

Suresh Poosala
OncoseekBio Pvt Ltd., Hyderabad

Avery August
College of Veterinary Medicine,
Cornell University, Ithaca

The high transmissibility of SARS- CoV-2, combined with a lack of population immunity and prevalence of severe clinical outcomes, urges the rapid development of effective therapeutic countermeasures. The team proposes to create a therapeutic by developing neutralizing novel antibodies (unique class of synthetic antigen-binding fragments) directed against the receptor-binding domain and other epitopes of the Spike protein of SARS-CoV-2, bind it to drug/Zn nanoparticle conjugates (ADCs), which would release the drug of choice at the site of action. Such a novel potential therapeutic entity would be administered by nasal inhalation (nebulizer), as a treatment and prophylactic, so that hospital visits are prevented and it can easily be administered at home.

5. Ivermectin for treatment of COVID-19

Sadhana Sathaye
Institute of Chemical Technology, Mumbai

Kamalesh K. Rao
Lifescient, Inc., San Francisco

Lifescient, Inc., and Institute of Chemical Technology (ICT) Mumbai are proposing an inhalable combination formulation of FDA approved medications - ivermectin and theophylline. This formulation can be delivered directly via a nebulizer to the lung epithelial cells of the COVID-19 patient both in the hospital and at home. Ivermectin, an antiparasiticide has shown significant antiviral activity against COVID-19 virus. Theophylline, a bronchodilator used to treat asthma is known to reduce inflammation and improve respiration. The formulation will address the pathology of acute respiratory distress syndrome, reduce mortality and associated morbidity in COVID-19 patients. Targeted delivery into the lungs will minimize systemic exposure with better therapeutic outcome.

Ignition Stage II Awardees

6. Reducing mortality due to COVID-19 with a simple, non-electric pressure ventilator

V Sashi Kumar
Phoenix Medical Systems, Chennai

Stephen John
Advanced Innovative Medical Technologies, LLC, Ann Arbor

NeoVent delivers non-electric, visually intuitive, non-invasive positive pressure ventilation to support patients in respiratory distress. With this clinicians can support patient oxygenation and ventilation through independently controlling the upper level of pressure, lower level of pressure and cycles per minute. The patent-pending, award-winning technology is non-electric, non-invasive, easy to setup and operate and costs less than 1/10th the cost of conventional ventilators.

7. Wearable sensor to monitor and track COVID-19 like signs and symptoms

Vaidy Narayanan
Bionic Yantra, Bengaluru

Arun Jayaraman
Northwestern University, Evanston

Molecular testing (RT-PCR) is the current gold-standard for diagnosing COVID-19, but test availability and response time still do not meet the required demand. The team aims to investigate the use of soft-wearables to develop a rapid-screening tool for diagnosing COVID-19 infections. They will leverage on the availability of a new class of skin-mounted devices, which conform to the body and can non-invasively record high resolution data on temperature, cardiac, respiratory and physical activity. The physiological signals data will be used to train an algorithm for assessing the risk of an individual presenting symptoms suggestive of a COVID-19 infection.

8. ENCEESPRAY – An electrostatic disinfection machine comprising of electrostatic sprayer and electro hypo generator – an ideal solution for surface disinfection against covid19

Abhijeet Gan
Rite Water Solutions
(I) Pvt. Ltd., Nagpur

Pratap Pullammanappallil
University of Florida, Gainesville

ENCEESPRAY is an Electrostatic Disinfection Machine comprising of electrostatic spraying unit and onsite disinfectant generator. Electrostatic disinfection is one of the most efficient and effective methods to apply the disinfectant and sanitizing agents to living and non-living surfaces. It offers a favourable approach to increase spray deposition to hidden areas with reduced usages of chemicals and natural resources. The onsite disinfectant generator produces disinfectant solution by electrolysis of salt solution thereby making it most cost-effective and environmentally friendly disinfectant. ENCEESPRAY produces charged droplets of disinfectant in the range of 10-20 µm thereby ensuring 360-degree coverage of all surfaced, best suited for disinfection of microbes. The project aims to test, validate, and introduce various models of electrostatic disinfection machines.

9. A Rapid Point-of-Care Fiber-optic Biosensor (P-FAB) Device for Early Detection of COVID-19 using Saliva

V.V. Raghavendra Sai
Indian Institute of Technology-Madras

Himanshu Bhatia
Ricovr Healthcare Inc., Princeton

This collaborative research project is set to simplify and expedite COVID-19 testing while making the cost of such an activity attainable for a broader range of usage. The plasmonic fiberoptic absorbance biosensor (P-FAB) technology is a point-of-care (PoC) device with a unique disposable fiber optic cartridge technology to detect SARS-CoV-2 antigens and virus particles directly in saliva (with minimal sample pre-processing). This fast, non-invasive device simplifies the collection and analysis of samples via an inventive wash-free single-step processing.

10. A Non-Invasive High Frequency Nasal Cannula Ventilation (vibratory Ventilation to address the COVID conditions)

Prasad Muddam

Heamac Healthcare Pvt. Ltd.
(Indian Institute of Technology), Hyderabad

Morarji Peesay

MedStar Georgetown University
Hospital, Washington DC

The team's Innovation High-Frequency Nasal Cannula (HIFINC) is a vibratory, high frequency, non-invasive ventilation for COVID conditions. This device is affordable, portable, and long-lasting and reusable. The team is repurposing this patent pending technology to match the requirements of the COVID associated respiratory issues such as ARDS, Pneumonia etc. The device will contain variable volume and frequency adjustments addressing neonatal/paediatric and adult ventilation. As it is low-cost, non-invasive technology, it can be adapted to major resource constrained settings; the automated design modifications will enable even low skilled staff to operate with ease. Technology acts gentle on lungs while providing maximum gas exchange.

11. Development of monoclonal antibody therapeutics for COVID-19

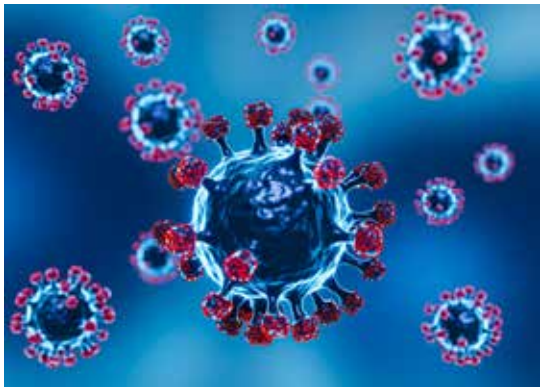
Maloy Ghosh

Zumutor Biologics Private Limited,
Bengaluru

Shiladitya Sengupta

Brigham and Women's Hospital, Harvard
Medical School, Cambridge

The team aims to develop monoclonal antibody therapeutics against spike protein of the SARS-CoV-2 from unique and versatile human antibody libraries. The project proposes a combination of antibody library screening technology and in silico approach to identify and validate novel monoclonal therapeutic antibodies. Additionally, they aim to develop novel monoclonal antibodies to counter appearance of mutated viral strains using in silico approach. As it is understood the COVID-19 disease will continue over years with appearance of mutated virus strains, this approach will provide a sustained therapeutic solution against the SARS-CoV-2 infection over a longer period.



Section IV: Research and Development

Research and Development

IUSSTF supports a broad portfolio of R&D programs in key strategic areas that are of mutual interest to both countries. The current portfolio includes flagship programs like the **Joint Clean Energy Research and Development Centre (JCERDC)** on **Smart Grid and Energy Storage; PACEsetter Fund** and the DST-Intel® **Real Time River Water and Air Quality Monitoring Initiative**.

Joint Clean Energy Research and Development Center (JCERDC)

The **Indo-U.S. Joint Clean Energy R&D Centre (JCERDC)** is a joint initiative of the Ministry of Science and Technology, Govt. of India and the U.S. Department of Energy. The aim of the program was to facilitate joint research and development on clean energy technologies that may be deployed rapidly with the greatest impact. The JCERDC is based on a public-private partnership model of funding and is a first-of-its-kind initiative. Phase I of the program began in the year 2012 with IUSSTF as the implementing agency. It brought together more than 100 Indian and U.S. academic and industrial partners to work jointly in the space of clean energy research.

Under Phase II of the program, the consortium titled ***"UI-ASSIST: U.S.-India collAborative for smart diStribution System wIth Storage"*** led in India by Suresh C. Srivastava from the Indian Institute of Technology (IIT) Kanpur, and in the United States by Noel Schulz from Washington State University, Pullman, was selected and awarded in September 2017.

Objective: UIASSIST Project

The overall objective of this project is to evolve the future distribution grid that will allow the continuing increase of Distributed Energy Resources (DER) penetration towards a sustainable electricity system. The research proposed will lead to the fully conceptualized smart distribution grid that optimally utilizes energy storage and distributed generation supported by workforce development and policy recommendation. The developed solutions will be validated on ten different unique lab test beds and deployed at ten different field demonstration pilot sites, five each in the U.S. and India.

UI-ASSIST: Institutional Engagement

India	USA
• **Indian Institute of Technology, Kanpur** • Indian Institute of Technology, Delhi • Indian Institute of Technology, Roorkee • Indian Institute of Technology, Madras • Indian Institute of Technology, Bhubaneswar • The Energy and Resources Institute, New Delhi • NTPC Energy Technology Research Alliance, Greater NOIDA • Power Grid Corporation of India Limited, Gurgaon • UP Power Corporation Limited, Lucknow • BSES Rajdhani Power Ltd., New Delhi • Synergy, Faridabad • Customized Energy Solution, Pune • Panasonic India Pvt. Ltd., Gurgaon • GE Global R & D, Bengaluru	• **Washington State University, Pullman** • Massachusetts Institute of Technology, Cambridge, • Texas A&M University, College Station • Hawaii Natural Energy Institute, Honolulu • National Renewable Energy Laboratory • Pacific Northwest National Laboratory • Lawrence Berkeley National Lab, Berkeley • Snohomish County Public Utility District No 1., Everett • Burns and McDonnell, Kansas City • ETAP, Operation technology, Inc., Irvine • National Rural Electric Cooperative Association, Arlington • AVISTA Utilities, Spokane • Venkata Consulting Solutions Inc. • Clean Energy Solutions • GE

Key Deliverables

The UI-ASSIST project is being managed through 11 distinct themes, with interlinked activities.

S. No.	Themes	Description
1	Finalizing Overall Product Management Architecture	The theme deals with overall planning and execution of various objectives of the project in a cohesive manner. This task also includes knowledge dissemination by publishing relevant updates on the website and interacting with the advisory board members.
2	Distribution System Modeling and Benchmark system development	The objective of this theme is to develop benchmark models which can be used by various research group members of this project to test and validate their research and development work.

S. No.	Themes	Description
3	Energy Storage • Modelling • Optimal Management	The team aims to analyse and model storage technology for smart distribution system under this theme. Hardware models will also be developed to study the impact of storage systems under dynamic operation of microgrids.
4	Microgrid and Active Distribution System • Converter • Primary Controller • Secondary Controller • Protection	This theme includes development of novel converter topologies, associated controls, and protection system for AC/DC microgrid application. As a part of this task, primary controller design, secondary controller design, and AC/DC microgrid protection mechanisms will be studied.
5	Cyber Security • Infrastructure • Measures	The objective of this theme is to study various cyber infrastructure suitable for smart distribution grid. It will also validate their performance to make the overall system reliable and tolerant to cyber-attacks.
6	DSO Functions/Energy Management • Forecasting • Market Management Systems (MMS) • Advanced Distribution Management System (ADMS) • Control and Optimizations • Planning	Load Profiling and Forecasting, System Reconfiguration and State Estimation, Optimal Operation of DERs, and Demand Side Management are covered under this theme.
7	Distribution System Operators (DSO)-Market and Regulatory Issues	Addressing market and regulatory Issues, distribution market development, Integration of market mechanisms with frequency regulation and volt-VAR control are the objectives of the theme.
8	Lab Testing and Validation • Offline • Real Time • Hardware-in-the-loop (HIL)	As a part of this theme five testbeds have been developed to test various research concepts developed as a part of R & D activities. This provides a mechanism to validate concepts in a lab environment before any possible deployment of technology.

S. No.	Themes	Description
9	Field Demonstration	Two urban, one rural and two semi-urban pilots are being developed as part of this theme under the project. The pilots will also provide a means to test new technology in real-life smart distribution system.
10	Impact analysis and Policy Recommendations	The societal impact of smart distribution grid will be studied under this theme, based on which various policy recommendations will be made to improve the impact of smart distribution system.
11	Workforce Development	Various workshops, training programs, and conferences will be organized to educate and train workforce members to operate, maintain, and sustain a smart distribution grid.

UI-ASSIST: Highlights

The research work related to all the themes is in an advanced stage and the implementation of pilot projects is currently ongoing. Highlights of the major progress made in the project include

- **Benchmark Systems:** A field pilot /utility data driven, benchmark of semi-urban and rural benchmark is being developed. The benchmark is capable of simulating grid-connected solar inverters. This model is in addition to the modified CIGRE model developed for co-simulation and the synthetic model. The benchmark is now being implemented in the IIT Kanpur lab testbed for further testing and co-verification of field data.
- **Energy Storage:** The BESS sizing and control algorithm development for all the applications identified under the three pilot sites within the BRPL licensee area has been completed.
    - The performance of a parametric variation based μ -synthesis robust controller for DC link voltage regulation of battery energy storage systems for frequency regulation and voltage quality enhancement of islanded microgrids has been validated using the real-time Typhoon HIL emulator. The robust controller is validated for BESS in AC microgrids.
    - A peak shaving and energy management system using BESS is also being developed. A scheme for optimal charge and discharge scheduling of storage systems to minimise battery utilisation and net energy consumption from the grid has been developed. Analysis of multi-cell configuration and behavioural analysis of multi-cell modules are also carried out.
- **Microgrid and Active Distribution system:** In this activity, the development of primary and secondary controllers for microgrids and various protection mechanisms for microgrids with energy storage have been studied. A novel islanding detection scheme for hybrid distributed generation has been developed. A relaying scheme which can differentiate between fault conditions in grid-connected and islanded modes of microgrids has been created. Other contributions include a battery and supercapacitor combination to effectively achieve DC link voltage restoration in inverters for microgrids, a cyber resilient control in DC microgrid clusters, and a secondary controller design for current sharing and low voltage regulation.

- **Cyber Infrastructure and Security:** The impact of jamming in free space optical (FSO) links over negative exponential fading channels combined with pointing errors, as well as the effect of relay jamming in a cooperative FSO communication system based on the decode-and-forward (DF) protocol, is being studied. Studies on GPS spoofing, anomaly detection, and physical layer attack prevention are also being carried out. A Feasibility Study of Communication Technologies for Microgrids and Active Distribution Networks has been performed.

- **DSO Functions and Energy Management:** This theme deals with the DSO function, optimal scheduling, and demand management systems. New methods for State Estimation, Load Flow, Network Reconfiguration, and Volt-Var Control. Algorithms for islanding detection, optimal operation of microgrids, RES, and storage in distribution networks are being designed. Case studies are performed on radial and meshed distribution networks. A new model for TSO-DSO interactions has also been developed.

- **DSO Market and Regulatory Issues:** The consortia have proposed a DSO model for India. Studies are being performed about energy trading in a decentralised market. An energy market framework using TSO-DSO coordination has been developed by utilising the resources available in the distribution system.

- **Lab Testing and Validation:** Development of all the test-beds is complete. All partnering consortiums have tested their R & D results in these test-beds. The team is working now to develop a battery inverter that will be part of one of the testbeds. The prototype is being fine-tuned to improve its connection to the testbed, and the rural benchmark is being implemented.

- **Field Demonstration:** Progress on setting up three field pilots is as follows

    - Installation of Urban Pilot with Thermal Energy Storage System (TESS) in CESE building, and Solar PV with Hybrid Inverter and BESS in Faculty towers has been completed.

    - All the installation work in the Semi-Urban pilot except the EV charging station is completed.

    - Installation of the rural pilot and overall integration of all three pilots with DSO/ADMS installed at the Smart Grid Control Centre is expected by July/August 2021.

    - Consortia in association with a partner utility (BRPL), is undertaking the installation of BESS at three different locations within the distribution licensee area of BRPL in the NCT of Delhi. Under category-A, the civil work is completed and the BESS container has been installed at the site adjacent to the existing LT feeder panel. The foundation for the installation of other associated components such as PCS and isolation transformers has also been built. Under category B & C, the civil work has been completed and the BESS container installation work is being undertaken.

- **Workforce Development** Most of the planned conferences, workshops, and meetings have been cancelled, postponed, or moved online because of the COVID-19 pandemic.

    - A webinar was conducted on Distribution System Operator (DSO): Emerging needs, roles, and responsibilities on October 24, 2020.

    - A 40-day workshop for skill development on smart grid technologies was attended by 30 ITI certificate holders in February and March 2021. The workshop focused on hands-on training on various aspects of smart-grid deployment.

- There were six invited talks on research activities as part of this project at the NPSC, organised in virtual mode by IIT Gandhinagar in December 2020.
- Many student webinars and expert talks are being organised on a monthly basis.
- In March 2021, a two-day virtual student e-conference was conducted, which was attended by all the students involved in the project in Indian Consortia.

No of Publications	216
No of Patents filed	3
Research Fellows Trained	218
Research Facilities / Test beds Created	6

- A summer UI-ASSIST review workshop was conducted virtually from July 21st to July 23, 2020. The workshop was attended by team members from India and the U.S., representatives from funding agencies-Department of Science and Technology, Govt. of India, the U.S. Department of Energy, Indo-U.S. Science and Technology Forum, and experts from the Smart Grids and Energy Storage domains.
- The Third Project Monitoring Committee (PMC) Meeting was held virtually on July 6, 2020. The PMC reviewed the progress of the project and shared their recommendations and insights with the team.

The thermal energy storage system with a 775 tonnes-of-refrigeration heat rate is installed at IIT Kanpur's Centre for Environmental Science and Engineering building as part of the UIASSIST project.

Indo-U.S. PACEsetter Fund

The Ministry of New and Renewable Energy (MNRE), Govt. of India and the U.S. Embassy support the PACEsetter Fund (PSF) which is an INR 50 crore (USD 7.9 million) fund jointly capitalized by the Governments of India and the United States of America. The Fund's main purpose is to improve the viability of off-grid renewable energy businesses that sell small-scale (under 1 megawatt) clean energy systems to individuals and communities without access to grid connected power or with limited/ intermittent access (less than 8 hours per day). IUSSTF is the administrator of the PSF.

PACEsetter Fund Round I

PSF Round–I was announced in 2015 and nine teams were selected for the award in 2016. These projects were reviewed twice by the Techno-Financial Expert Committee (TFEC) and in 2020-21, after a final review, they were successfully concluded. Highlights of the projects awarded under Round I are given below:

1. **High rate biomethanation of organic waste for generation of power for off-grid applications led by M/s Ahuja Engineering Services Pvt Ltd (AES), Secunderabad**

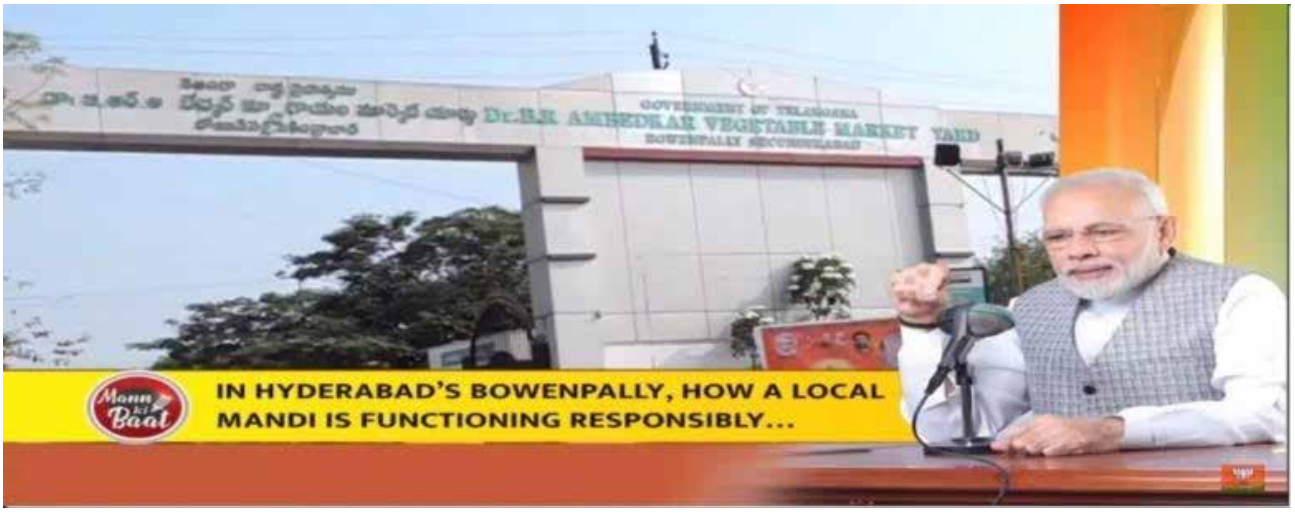
The objective of the project was to implement a model for generation of off-grid power through high-rate bio-methanation technology that generates quality biogas from organic waste, coupled with proper waste disposal and management. The team has been successfully able to commission a 5 ton capacity bio-methanation plant along with a DG set for power generation at Jawahar Nagar Dump Site and the same has been handed over to Hyderabad Integrated MSW LTD (HIMSW) for operations since April 2019.

Special achievement: The funding support through the PACEsetter Fund program enabled the team to successfully develop and demonstrate the technology at a smaller 5 TPD scale. This project gave them the confidence and proof–of-concept, helping them to leverage additional funds from other funding agencies for scaling up the project to the working of 10 TPD. Consequently, a successful business model of distributive waste management has been implemented by the Department of Agriculture, Govt. of Telangana in B R Ambedkar Vegetable Market, Bowenpally, Hyderabad (one of Telangana's biggest vegetable market yards) with support of the Department of Biotechnology (DBT), Government of India.

The PACEsetter Fund is also extremely proud that the team's activities has been appreciated and acknowledged by the Hon'ble Prime Minister of India Shri Narendra Modi in Mann Ki Baat with the nation on January 31, 2021.

https://www.youtube.com/watch?v=mt5qghFlA9U
[Mann Ki Baat] (Time Stamp: 13:00)

https://www.youtube.com/watch?v=LRGkoF4Lww4
[Governor's address]



2. Unlocking clean home energy for the base of the pyramid: Developing and piloting the world's first Pay-As-You-Go (PAYG) Integrated Home Energy System in India led by M/s Biolite, Brooklyn (NY), USA

The project focused on developing an off-grid integrated home energy system (IHS) that combined the health and environmental benefits of clean cooking with the power generation of a solar home system. The product development aspect of the project focused not only on the modularity and additionality of the system - enabling users to add panels, batteries and accessories as their energy needs expanded- but also on integrating BioLite's own PAY-GO system, compatible with their partners' Customer relationship management systems, to support the financing of the bundle.

3. Waste to energy innovation at small-scale led by M/s Grassroots Energy Inc., Massachusetts and SEWA Bharat, New Delhi as the Partnering entity

The aim of the project was to demonstrate small-scale bio-mass powered mini-grids from agri-wastes to set up distributed energy services while combining two innovative solutions to solve energy access; using local waste resources from dairy farms and process into Biogas to generate electricity and recover the waste heat.

Together Grassroots and SEWA Bharat team has been able to successfully deploy three small -scale bio-mass powered mini-grids from agri-wastes to set-up distributed energy services at the project sites Nawagadi, Jamalpur and Haveli-Kharagpur in the Munger District of Bihar. The team has extensively spent time to understand the pain areas of the communities with respect to access to energy. Understanding the growing need of the community for electricity beyond basic lighting, productive loads were identified and targeted solutions were developed.

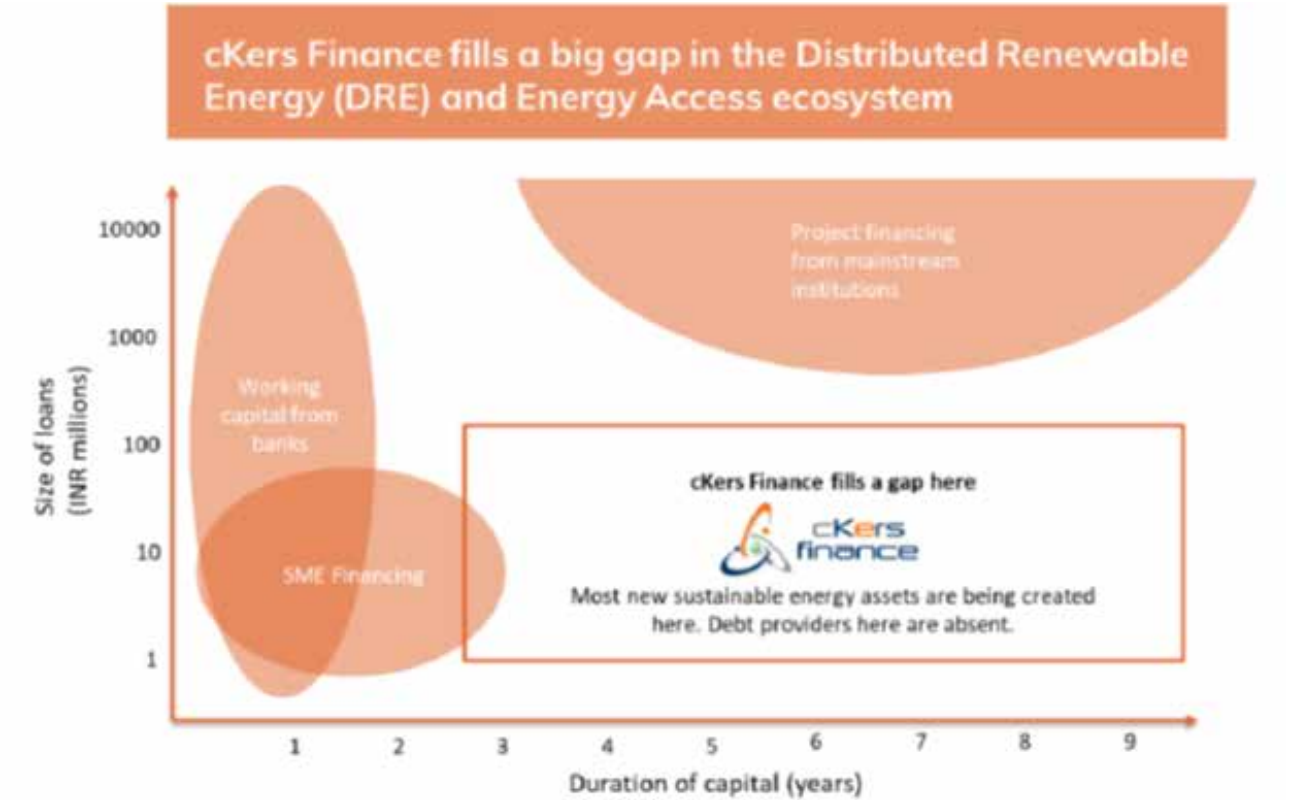
A self - sustainable small scale model for the Biogas operation has been created for the village community. A robust system has been developed to collect the feedstock from nearby dairy farmers and generate biogas on a daily basis. The farmer in lieu gets veterinary medicines for the cattle from the company.

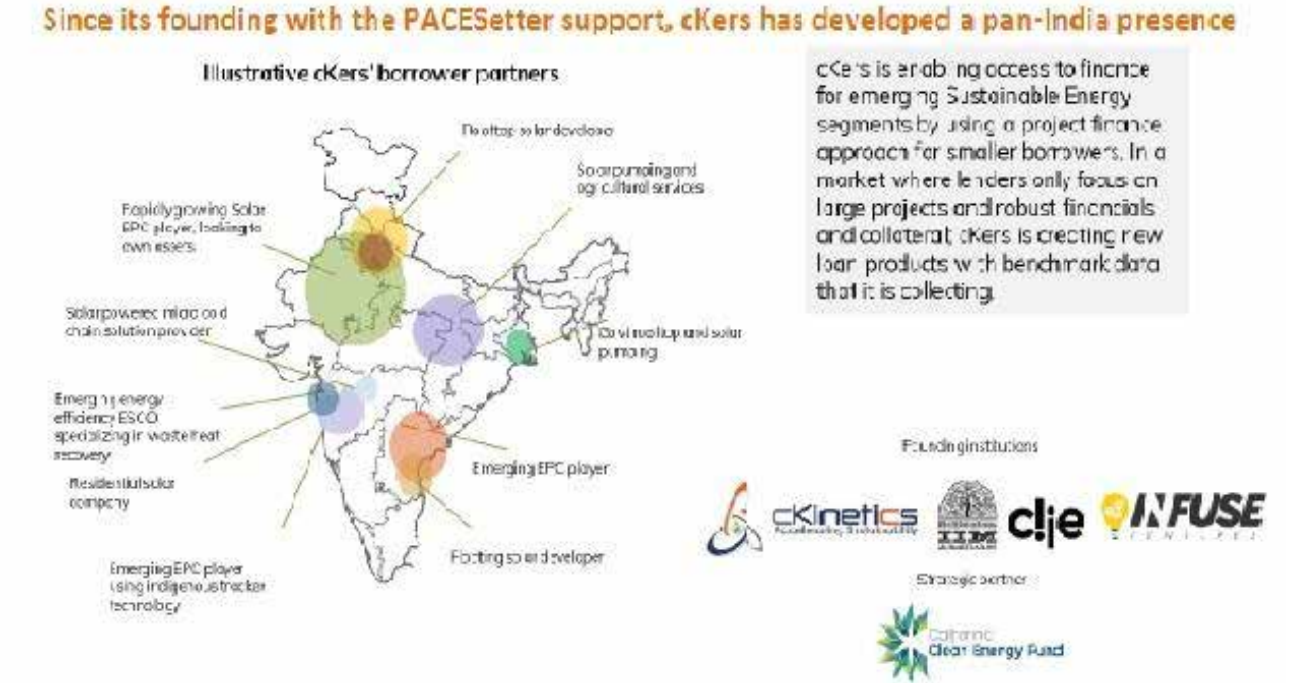
Modular, decentralized, plug flow digesters with ease of use and implementation has been designed and made operational. Semi-automation processes are implemented to expedite the feeding process and reduce the manual work.

The Electricity generated from the plant is able to provide high quality three phase power which is used for small and medium operations like running of RO water plant, Compost Sieving, Sludge pump, Stirrer, flour machines, shredding, dehydrator and electrical Vehicles charging points.

4. Creation of an innovative market maker debt provider (incorporated as cKers Finance Private Limited) to catalyze growth of market players in Decentralized Renewable Energy (DRE) based energy access projects led by M/s cKers Finance Private Limited Pvt. Ltd., New Delhi

The project aimed to use a market-maker debt financing approach to provide Decentralized Renewable Energy (DRE) based Energy Access Projects with their initial debt; and in the future leverage mainstream capital by creating a Joint venture by cKinetics and CIIE for a Debt financing venture to lend to companies working in the DRE space in India at rates, tenor and terms that are absorbable.





cKers finance has developed products by considering the following:

1. Making small-ticket loans for renewables viable
2. Providing financial products that align with customer cash-flows
3. Creating under-writing frameworks for new sustainable energy segments

Special achievement: In March 2021, cKers Finance Private Limited and Electronica Finance have received a loan worth $41 million jointly sponsored by the United States Agency for International Development (USAID) and the U.S. International Development Finance Corporation (DFC) to improve access to clean, steady, and affordable energy progress towards India's clean energy transition and climate change mitigation.

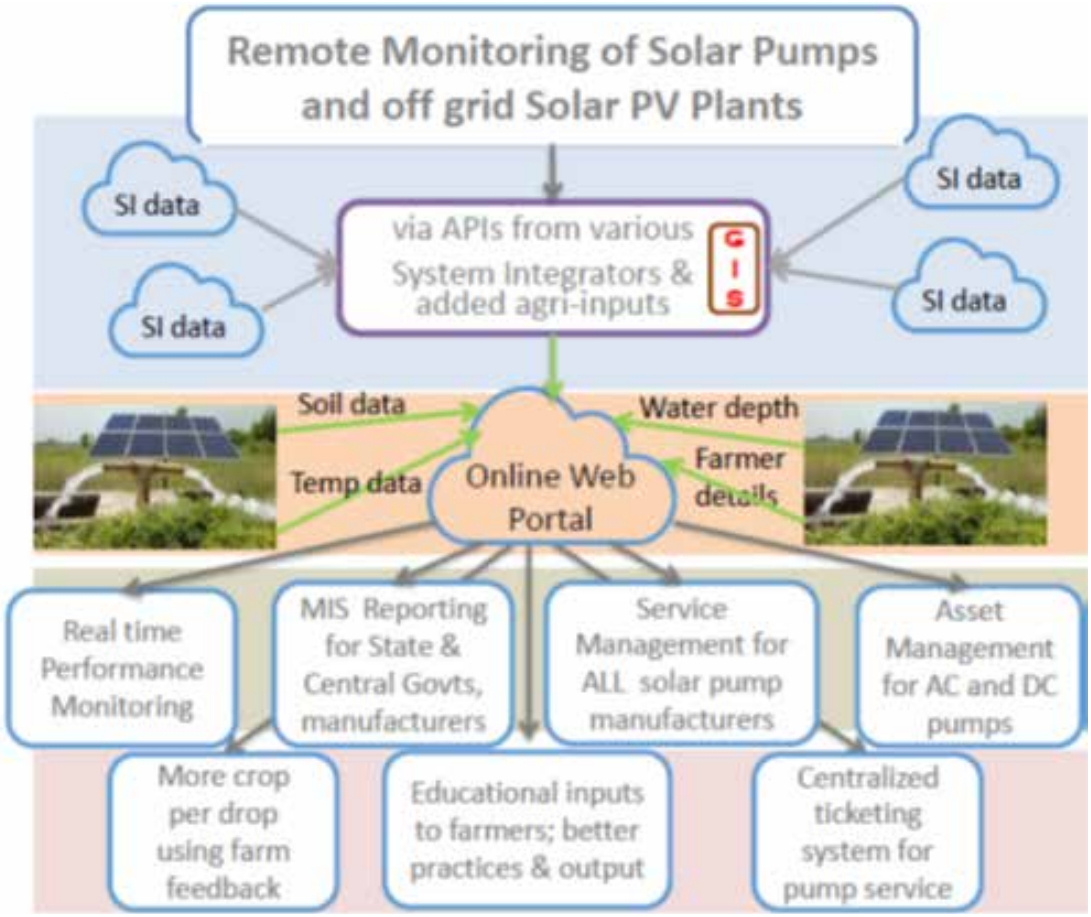
https://www.thehindubusinessline.com/news/usaid-and-dfc-to-sponsor-41-million-loan-guarantee-program-in-india-to-finance-rooftop-solar/article34098404.ece

5. Study of solar pumps program effectiveness and proposal for deployment of remote performance monitoring & outsourced service management of solar pumps and off-grid solar PV plants through an online portal with pilot demonstration projects in Andhra Pradesh and Chhattisgarh states in India led by M/s Shri Shakti Alternative Energy Ltd. (SSAEL), Hyderabad

The goal of the project was to remote monitor the performance of off-grid solar pumps and Solar PV power plants leading to controlled and optimised use of energy and water for agriculture.

SSAEL has developed a GIS-enabled Management Information System for the remote monitoring and service handling of solar pumps and off-grid solar power plants. The system will facilitate in directly linking different stakeholders like the pump manufacturers, farmers, technicians and the State Nodal Agencies under one platform. In order to undertake service management by the Pump Manufactures, an App has also been developed, which can be used by the Farmers and the Technicians to attend any malfunctioning of the pump. The system has been put to test in Andhra Pradesh and Chhattisgarh with cooperation and feedback from NREDCAP and CREDA, the respective State Nodal Agencies (SNAs) of MNRE.

The platform included an additional GIS mapping component and the ability to receive the pump performance data through APIs (Application Programming Interface) from the manufacturers who are using different RTUs (Remote Transmission Units). This innovative and desirable extension expanded the coverage scope of monitored pumps from 450 to 1611 in the pilot demonstration stage.



SEWA Portal GURI

SEWA Farmer & Technician App

6. Microgrid remote monitoring & control led by M/s Customized Energy Solutions India Pvt. Ltd., Pune

The project aimed to develop a robust remote monitoring solution for microgrids along with its interface with centralized MIS to optimize the battery system through a portal for stakeholders to communicate through this MIS platform and exchange the details of projects, direct access to funding agencies, and direct view of upcoming projects to the equipment.

A Manual cum practitioner's handbook as a user-guide has been designed by the company detailing the outcome of the project based on the study carried out at 36 sites along with data and graphic analysis with respect to all parameters for each site. This manual is an attempt to be a guide for the people involved in sizing, designing, installing, operating and maintaining solar PV plants with lead acid batteries which will result in increasing output of power plants & life of batteries by 30% to 50%.

7. Powering agriculture: Community based solar pumps led by M/s Environment Conservation Society (SwitchON), Kolkata

The objective of the project was to develop community-based irrigation models focussing on financing linkage, ICT platform and solar pumps with new technology (e.g. movable, remote monitoring) for clean energy access.

Solar Irrigation Pump technology has been considered to be a proven-technology with paybacks of ~3 years however the banks are not comfortable financing "un-bankable" farmers. To address the challenges and with an aim to unlock finance for solar pumps, SwitchON Foundation with support from PACEsetter

Fund has set up a First Loss Default Guarantee (FLDG) fund in partnership with RBL Bank to provide marginal farmers with loans for acquiring solar pumps. The FLDG was set up to de-risk the lending by commercial banks and allow the farmer to easily avail a loan by saving between $50-100 per month as there is no recurring expense on irrigation. Hence farmers are able to save and also generate more income from agriculture.

The initial process involved identifying the sites for intervention. Once the areas were finalised, a baseline survey of 289 villages and 1880 socio-economic survey of farmers was conducted to identify potential consumers of solar pumps. Post identification – sensitization programmes, exposure visits and meetings were conducted to aware both bank employees and farmers about solar pumping systems. The farmers who were keen on acquiring solar pumps, were clubbed into a Water User Group or Joint Liability Groups (JLG). Further, the FLDG funds were used as a guarantee for facilitating the loan for solar pumps. SwitchON Foundation constantly monitored the repayment of EMI from the JLGs. The process of implementation is carried out according to the SPEAR Model (Select, Propagate, Engage, Approve & Repay).

At the end of the project 30 WUG's / JLGs received loan for solar pumps from RBL bank - which directly impacted 224 farmers positively. In the course of the project SwitchON also formulated an innovative formula for site selection, which has proved to be a very effective instrument for maximising output accordingly. There has been no default on the loan EMI's.

The following two projects had to be pre-closed due to the technical challenges faced by the teams:

- Development of user-friendly gasifier and engine system for irrigation led by M/s Optima Heat Technologies, Paramakudi
- Solar PV micro grids for remote hamlet electrification led by M/s Mera Gao Micro Grid Power Pvt Ltd, Lucknow

PACEsetter Fund Round II

Under the Call for PSF Round-II, the following four projects were awarded during an award ceremony held on September 20, 2019 at MNRE, New Delhi.

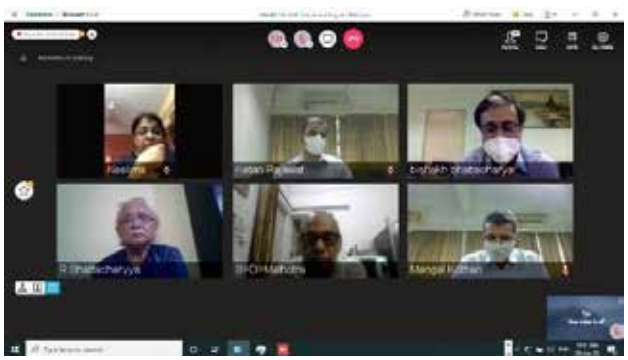
1. Development of Unglazed Transpired Solar Air Dryer (UTSAD) with energy management system, led by Raghavendra Suntech Systems Pvt Ltd (RSSPL), Bengaluru
2. Solar dryer-based self-employment model for rural tribal communities, women and differently-abled persons, led by The Energy & Resources Institute (TERI), New Delhi and co lead by Society for Energy, Environment and Development (SEED), Hyderabad
3. Rural enterprise model for branded packaged diced and dehydrated vegetables and other dried products using hybrid biomass and solar energy, led by Society for Economic and Social Studies, New Delhi
4. Intelligent solar charge controller for increasing energy output & life cycle batteries and revival of under-performing old SPV & their batteries, led by Customized Energy Solutions India Pvt. Ltd., Pune

Research Initiative for Real-time River Water and Air Quality Monitoring

Recognizing the importance of developing online River Water and Air Quality Monitoring (WAQM) systems, the Department of Science and Technology (DST), Government of India and Intel® have collaborated to jointly initiate the Research Initiative for Real-time River Water and Air Quality Monitoring. The intent was to develop tools and constituent blocks than will enable end-to-end water and air quality monitoring systems on smart, networked, low cost, low power sensor nodes with large-scale cloud-based data analysis. The program is administered by the Indo-US S&T Forum. Under the WAQM call, four projects were awarded in 2017. Of these, two each have been funded under the 'Air' and 'Water' Quality Monitoring categories respectively.

Highlights

- Given that site-visits or in-person meetings were not feasible due to the COVID-19 pandemic and associated lockdowns, the fifth Project Monitoring Committee Meeting was held virtually on 25 -26 June 2020, to review the scientific outcomes of the four projects and monitor their progress in conformity with the milestones, targets and objectives. The two Air Quality projects were reviewed on 25th June, followed by the two Water Quality projects on 26th June.
- After reviewing the progress of all projects at the end of Year 3, the PMC recommended that the IIT-Kanpur Air and IIT-Kanpur Water projects be given a no-cost extension to wrap up activities by 30th June 2021, and the IISc-Bangalore Air team and the IIT-Delhi Water project were asked to wrap up activities by December 2020.



Accomplishments of the four projects are given below:

1. Streaming Analytics over Temporal Variables from Air quality Monitoring (SATVAM)

Lead Indian PI (Name & Institute)
Dr. Sachchida Nand Tripathi, Indian Institute of Technology Kanpur

Other Partners (India and U.S.)

Collaborating Institutions, India	Collaborating Institutions, USA
• Indian Institute of Technology Kanpur, Kanpur (IITK) • Indian Institute of Technology Bombay (IITB) • Indian Institute of Science (IISc) Bangalore **Other Industrial Partners:** • Respirer Living Sciences Pvt. Ltd., Mumbai	• Duke University (DU), Durham

Project Objectives

a) SATVAM aims to collect air quality information sustainably, nation-wide, at a low-cost to allow policy makers and citizens to deploy data-driven control and preventive mechanisms.

b) Key objectives include focus on low-cost PM2.5 (Particulate Matter with aerodynamic diameter ≤2.5 μm) laser scattering sensors, Ozone, NOx and SOx sensors; concentrated photovoltaic conversion followed by Li-ion battery-based storage. Together, the idea is to integrate the entire hardware, communication and software stack, from local sensing to distributed analytics, to offer a comprehensive solution.

Notable Achievements

- Development & deployment of 30 SATVAM air quality monitors using multiple technologies – 6LoWPAN & GPRS.
- Detailed experimentation on field calibration of swapped out sensor boxes. · Towards transferable calibration model is performed.
- Co-location experiment to calibrate 17 new and 7 old sensor nodes at IIT Kanpur. Initial results from sensors spread/deployed at IITK campus.
- Solar powered SATVAM sensor box was demonstrated operation at par with the grid-powered boxes.
- Development of novel design of a static concentrator system.
- Finding optimal operating condition for an advection–cooled concentrated PV system.
- Two axis tracker designed and developed for further development of concentrator based power unit.

- The distinctive attribute of the SATVAM V2.2 gas sensor board is its significantly reduced cost and area.
- Updated calibration models and analytics including time series features from co-collection data at IIT-K from 25 motes.

Paper(s) published thus far: Annexure III

2. High resolution air quality monitoring and air pollutant data analytics

Lead Indian PI (Name & Institute)
Prof. Amrutur Bharadwaj, Indian Institute of Science, Bangalore

Other Partners (India and U.S.)

Collaborating Institutions, India	Collaborating Institutions, USA
• Indian Institute of Science, Bangalore • CSIR-Central Electronics Engineering Research Institute (CEERI), Pilani	• University of Southern California

Project Objectives

- To develop and validate a low-cost sensor system for measuring the air quality index; develop techniques for low-cost sensors to be used in conjunction with a small number of high quality, but expensive sensors, and guarantee data quality.

Deliverables

- Low cost Air Quality Monitoring, IoT device with COx, SOx, NOx, VOCs (Benzene, Toluene & Formaldehyde), PM 2.5 and PM10 sensors. At least 15 devices to be field tested.
- Air quality and other sensor data sets collected during the pilot deployments. Data for at least a few months from at least 15 locations will be collected using in-house sensors along with data from high quality sensor.
- Report describing the design, analysis and evaluation of novel algorithms developed for air quality sensor network data collection, calibration, data fusion and signal processing.

Notable Achievements

- To calibrate sensors at different humidity levels, IISc team developed a novel methodology for maintaining humidity at levels of 30%, 55% & 80%, using saturated salts (like MgCl, NaBr, KCl).
- Fabrication of CO Sensor and mastering the lab calibration methodology.
- Streamlined the fabrication process for metal-oxide sensors for CO, CO2 and NO, and NO2 with yields for functional devices exceeding 60%.

- Created a generic electronic interface to be able to integrate any Chemiresistive Sensors.
- Designed, fabricated, packaged and lab-characterized three metal-oxide based sensors for VOCs: Benzene (C6H6), Toluene (C7H8), and Formaldehyde (HCHO).

3. Design and Development of Aquatic Autonomous Observatory (Niracara Svayamsasita VedhShala - NSVS) for In situ Monitoring, Real Time Data Transmission and Web based Visualization

Lead Indian PI (Name & Institute)
Dr. Bishakh Bhattacharya, Indian Institute of Technology Kanpur

Other Partners (India and U.S.)

Collaborating Institutions, India	Collaborating Institutions, USA
• Indian Institute of Technology, Kanpur (IITK) **Other Industrial Partners:** • Kritsnam Technologies, Kanpur	• Woods Hole Oceanographic Institution (WHOI)

Project Objectives

- To design and develop low-cost, multi-parameter, water quality platforms that would consist of several in-house developed sensors and auto-sampling capability for durable and reliable real-time monitoring.
- To deliver a low-cost, autonomous real-time water quality-monitoring platform with auto-sampling capabilities.

Notable Achievements

- Conductivity sensor developed from a micro- mechanoelectrical system (MEMS) for in situ measurements of conductivity, and the sensing part is printed on a ~3×3 cm2 circuit paper, which makes it compact and easy to integrate with other sensing components.
- pH sensor consists of a conventional glass type pH sensor, but is engineered to cost only a fraction of commercial pH sensors.
- DO sensor is based on the fluorescence quenching method, and is designed and engineered to be small in size (sensing part ~1 cm3), low power, and deployable underwater.

Patents and Paper(s) published thus far: Annexure IV

4. Integrated low-cost water sensors for real- time river water monitoring and decision- making

Lead Indian PI (Name & Institute)
Dr. Arun Kumar, Indian Institute of Technology Delhi

Other Partners (India and U.S.)

Collaborating Institutions, India	Collaborating Institutions, USA
• Indian Institute of Technology, Delhi (IITD) • National Institute of Science and Technology (NIST), Berhampur • National Environmental Engineering and Research Institute (NEERI) Nagpur • Centre for Materials for Electronics Technology (CMET), Pune • University of Hyderabad, Hyderabad **Other Industrial Partners:** • Asiczen Technologies India Pvt. Ltd., Bhubaneswar • SunMoksha Pvt. Ltd., Bangalore	• University of California (UCR), Riverside • Michigan State University (MSU), East Lansing • Stanford University (SU), Palo Alto • New Jersey Institute of Technology (NJIT) Newark

Project Objectives

To develop sensors for chemical oxygen demand (COD), microbial indicators and water flow which can be used for determining water quality parameters as well as water flow characteristics in a river; integrate commercial sensors for obtaining water quality parameters with above-developed sensors using integrated ASIC chip; and integrate real-time data for developing an early warning system.

Deliverables

- Field trials of sensors developed at IITD drain
- Conducting of sensitivity & uncertainty analysis; scenario assessment
- Development of Mobile Application for Human assisted sensing
- Development of Intelligent model for sensor data compensation
- Deployment of prototype model devices in a test bed and demonstration of the test bed

Notable Achievements

- Development of sensors and solar cells, standardizing method for pathogen detection and developing models for prediction purposes which can be used to develop a buoy for getting real-time pollution data from river water.
- COD microchip assembly has been miniaturized with integrated circuit and microfluidics.
- Sensor for detecting Escherichia coli was standardized and then its ability to detect faecal coliforms in water was demonstrated.

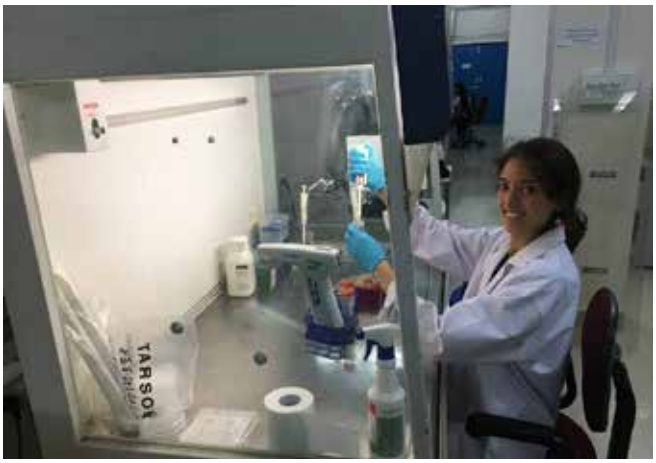
Paper(s) published thus far: Publications and Applied Patents: Annexure V

Section V:
Visitations and Fellowships

Visitations and Fellowships

It has been unambiguously demonstrated that providing students and young scientists an exposure to cutting-edge scientific research experiences at a formative stage not only broadens their intellectual horizons but also leads to increased engagements in scientific and technological research careers.

IUSSTF collaborates with several Federal agencies, Industry, Professional Bodies and Not-for-profit Organizations to administer a large number of Visitation Programs, across various domains and stakeholder levels.



Overall Matrix of Visitation Programs

S.No.	Name of Program	Partners*	Area	No. of Internships/ Fellowships
1	Indo-U.S. Genome Engineering/Editing Technology Initiative (GETin)	DBT	Genome engineering/ editing technology	5 Student Internships 5 Overseas Fellowships 5 Visiting Fellowship
2	Indo-U.S. Fellowship for Women in STEMM (WISTEMM)	DST	Science, Technology, Engineering, Mathematics and Medicine	10 Student Internships 10 Overseas Fellowships
3	Water Advanced Research and Innovation (WARI) Fellowship	DST, UNL and DWFI	Water Science and Engineering	5 Student Internships; 5 Fellowships
4	Bhaskara Advanced Solar Energy (BASE) Fellowship	DST	Solar Energy	7 Student Internships; 7 Fellowships
5	Bioenergy-Awards for Cutting Edge Research (B-ACER)	DBT	Biofuel and Bioenergy	5 Student Internships; 5 Fellowships
6	Building Energy Efficiency Higher & Advanced Network (BHAVAN) Fellowships	DST	Building Energy Efficiency	7 Student Internships; 7 Fellowships
7	IUSSTF–American Physical Society Fellowships	APS	Physics	4 Professorships; 4 Fellowships
8	ASM-IUSSTF Indo-US Professorship in Microbiology	ASM	Microbiology	Up to 5 Professorships
9	Research Internships in Science and Engineering		All areas of Science and Technology	Up to 30 Internships

S.No.	Name of Program	Partners*	Area	No. of Internships/ Fellowships
10	Khorana Program for Scholars	DBT and WINStep Forward	Life Sciences	50 Student Internships
11	IUSSTF-Viterbi Program	USC	Electrical Engineering, Computer Sciences and Computational Sciences.	15 Student Internships

*PARTNERS

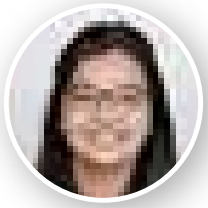
- APS- American Physical Society
- ASM- American Society for Microbiology
- DBT- Department of Biotechnology, Govt. of India
- DST-Department of Science and Technology, Govt. of India
- DWFI- Robert B. Daughtery Water for Food Institute at the University of Nebraska
- SERB-Science and Engineering Research Board, Govt. of India
- UNL- University of Nebraska- Lincoln
- USC- University of Southern California, Los Angeles

In March 2020, when the World Health Organization declared COVID-19 a global pandemic, many Interns and Fellows of the 2019 batch under various programs (WISTEMM, B-ACER, BHAVAN, Khorana) were in the middle of their research tenure in the United States. With India declaring a lockdown, closure of universities, and the suspension of international air-travel; IUSSTF worked closely with the Science Counselor at the Indian Embassy in Washington DC to facilitate the return of these awardees to India via Vande Bharat Mission Air India (VBM-AI) flights.

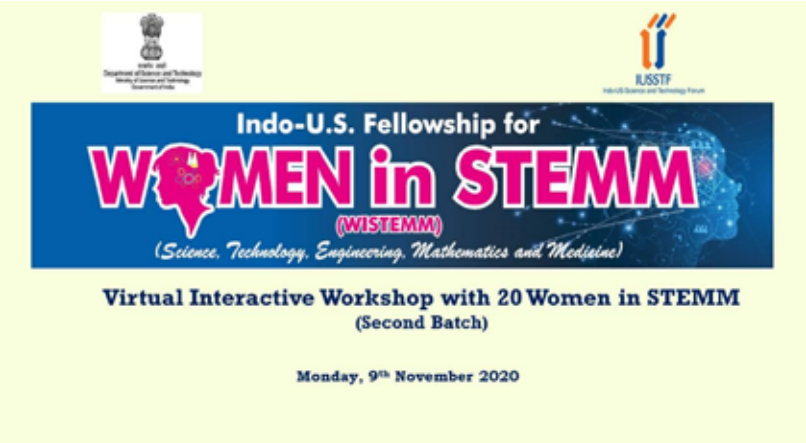
Also due to the pandemic, most of IUSSTF's visitation programs were placed on hiatus in 2020-21.

Highlights of the Year

- **IUSSTF- Viterbi Program-** 15 students were selected for the program however due to the pandemic; all global travel was put on hold. The selected students were provided with an option to undertake virtual internship. The following seven students finally undertook the virtual internship:

S.No.	Name	Institution	Research Topic & Mentor	Photograph
1	Chirag	Indian Institute of Technology (IIT) Roorkee	Low-Power Phase Change Oscillators for Neuromorphic Computing ***Mentor: Dr. Jayakanth Ravichandran***	
2	Deepika Soni	Indian Institute of Technology (IIT) Gandhi Nagar	Energy Efficient Hardware Accelerators for Convolution Neural Networks ***Mentor :Prof Peter Beerel***	
3	Mrigank Raman	Indian Institute of Technology (IIT) Delhi	Knowledge Graph based NLP methods ***Mentor: Dr. Xiang Ren***	
4	Raghav Bansal	Birla Institute of Technology and Science, Pilani, Rajasthan	Biosensor Circuit Design for RF Applications ***Mentor: Prof. Constantine Sideris***	
5	Rakesh Pavan	National Institute of Technology Srinivasanagar Surathkal	Fair & Private Machine Learning ***Mentor: Prof. Meisam Razaviyayan***	
6	Shashvat Jayakrishnan	National Institute of Technology Tiruchirapalli, Tamil Nadu	Model Predictive Control for Robot Motion Planning ***Mentor: Prof. Satyandra K. Gupta***	
7	Siddhant Agarwal	Indian Institute of Technology (IIT) Kharagpur	Visual Commonsense Reasoning ***Mentor: Prof Xiang Ren***	

- **Virtual Interactive WISTEMM Workshop** - IUSSTF, in partnership with the Department of Science and Technology (DST), Govt. of India, hosted a Virtual Workshop on November 9, 2020, to highlight the accomplishments of the Second Cohort of WISTEMM awardees. Participants included awardees, a panel of experts representing different STEMM disciplines, and officials from IUSSTF and DST. The workshop provided a platform for awardees to present their research and provide feedback about the program. DST and IUSSTF officials also solicited feedback from area experts about the program's impact and sustainability, and sought recommendations for program improvement.



Panellists shared their insights with the WISTEMM awardees on the values of critical thinking, increasing innovation through multi-disciplinary research, fostering international collaborations, and creating networking opportunities at the institutional/organizational level to engage and support women researchers.

- **Bioenergy-Awards for Cutting Edge Research (B-ACER) Program : First Virtual Conclave -** IUSSTF organized a Virtual Conclave on December 21, 2020 to highlight the accomplishments of four batches of Awardees under the Bioenergy Awards for Cutting Edge Research (B-ACER) program supported by the Department of Biotechnology (DBT), Government of India. The two main aims of the Conclave were to encourage students/young faculty from all the four batches to meet one another, and to not only discuss exciting advances and opportunities in their own research fields, but also learn and discuss about research at the cutting edge of other disciplines; and, to allow domain experts and agency officials who support the program to learn more about the research work these awardees accomplished during their respective internships/fellowships in the United States. Few U.S. mentors also participated in the Conclave and shared their thoughts on the growing collaboration between the U.S. and India in the field of Bioenergy.


BIOENERGY AWARDS
for Cutting Edge Research (B-ACER)
First B-ACER
Virtual Conclave

Section VI:
Money Matters

Money Matters

IUSSTF receives funding from three broad channels:

- Direct support from the U.S. government
- Direct support from the Indian Government
- Extra Mural Programs (EMPs)

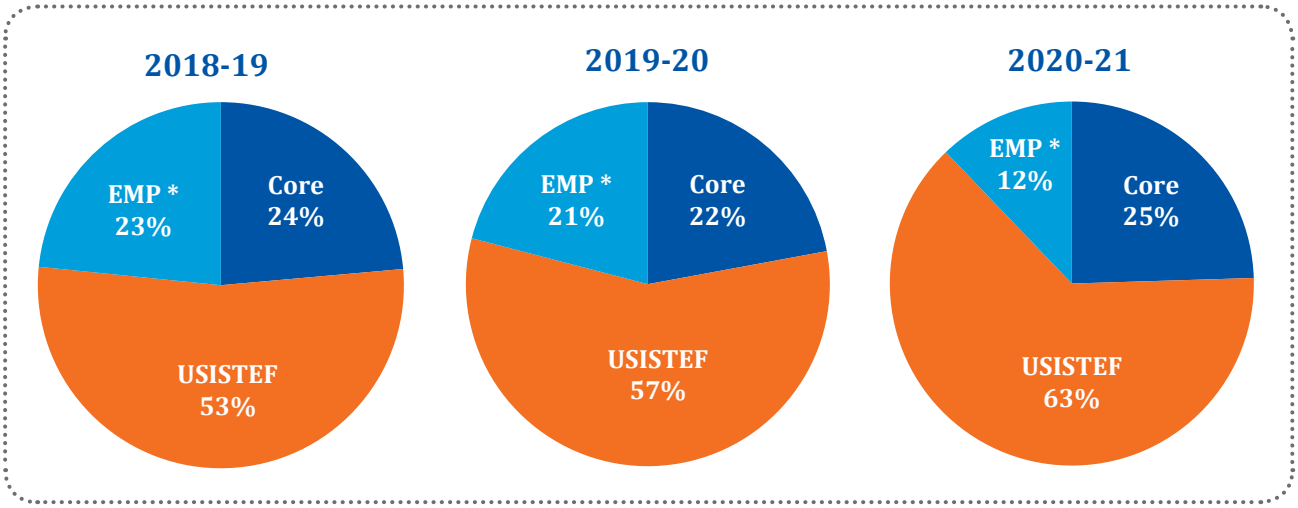
The support from the U.S. Government comes by way of annual interest on two separate Endowments (IUSSTF and USISTEF), to which the Indian Government provides matching grants annually.

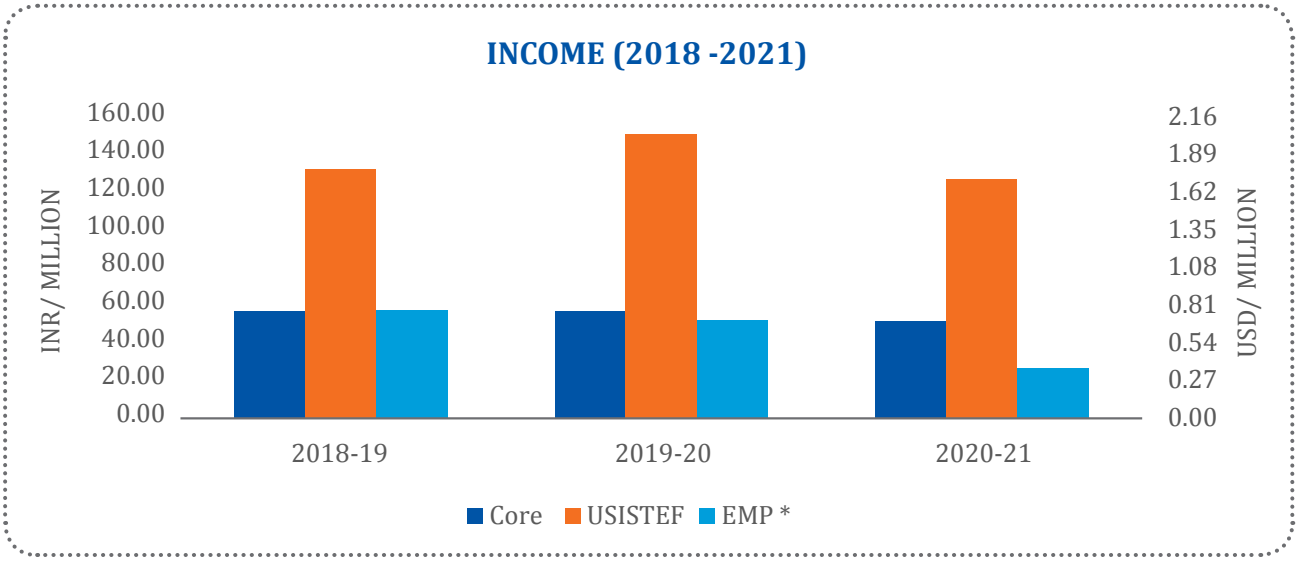
Support for the EMPs is received from various federal agencies such as DST, DBT, MNRE, SERB and Industry. Such support is provided in project mode for the implementation of specific program(s), against a nominal management fee and overheads.

(A) Overall Income

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	Core	57.61	0.78	57.05	0.77	48.22	0.65
2	USISTEF	129.49	1.75	147.10	1.99	124.54	1.68
3	EMP *	57.14	0.77	54.07	0.73	23.93	0.32
TOTAL		**244.24**	**3.30**	**258.22**	**3.49**	**196.69**	**2.66**

** EMP income exclude targeted funds received from the funding agencies*
I USD= 74 INR

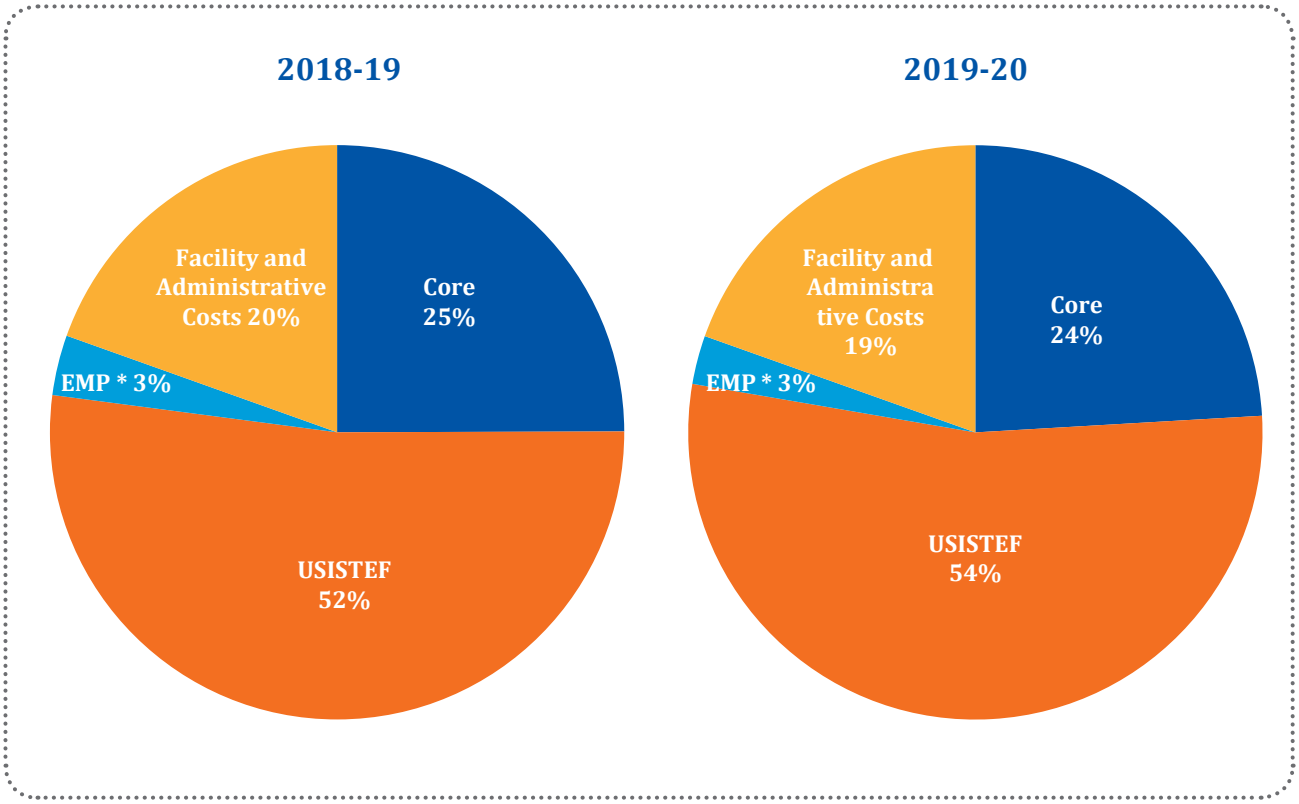


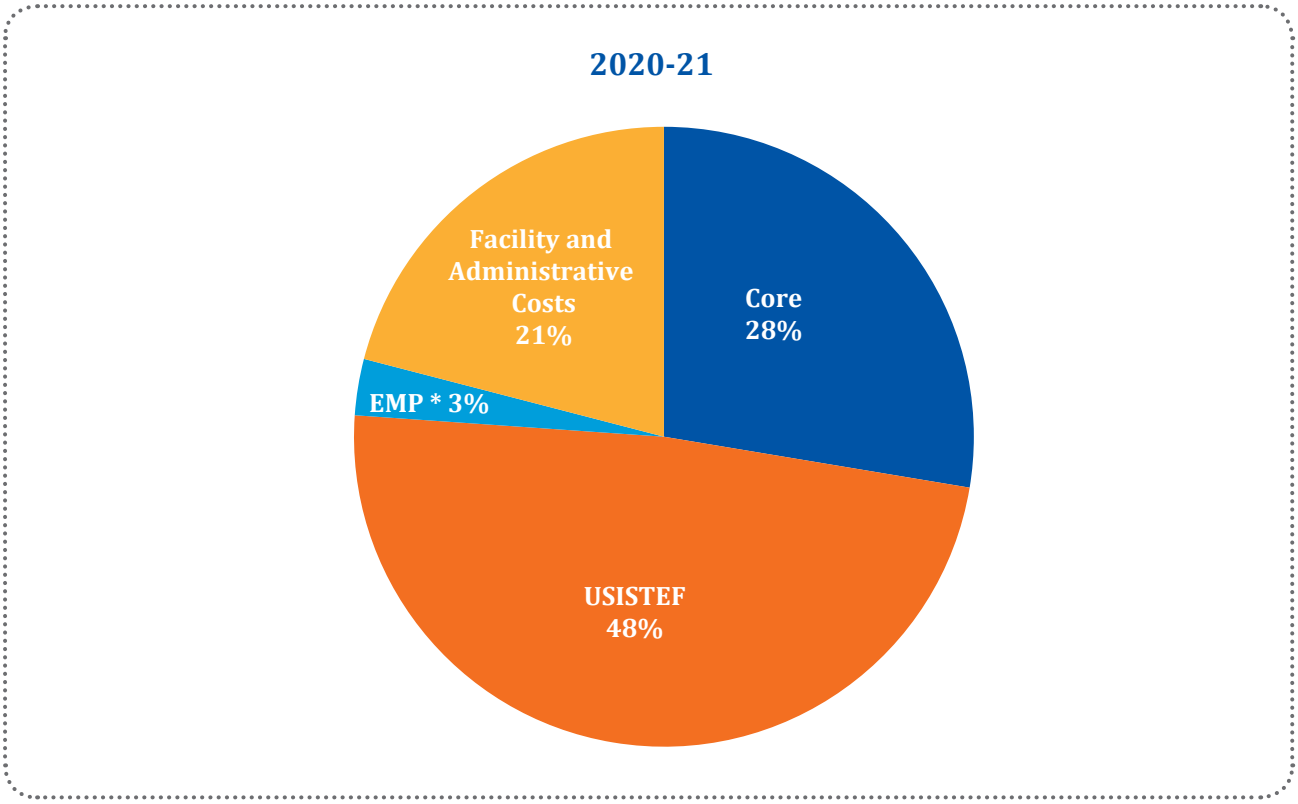


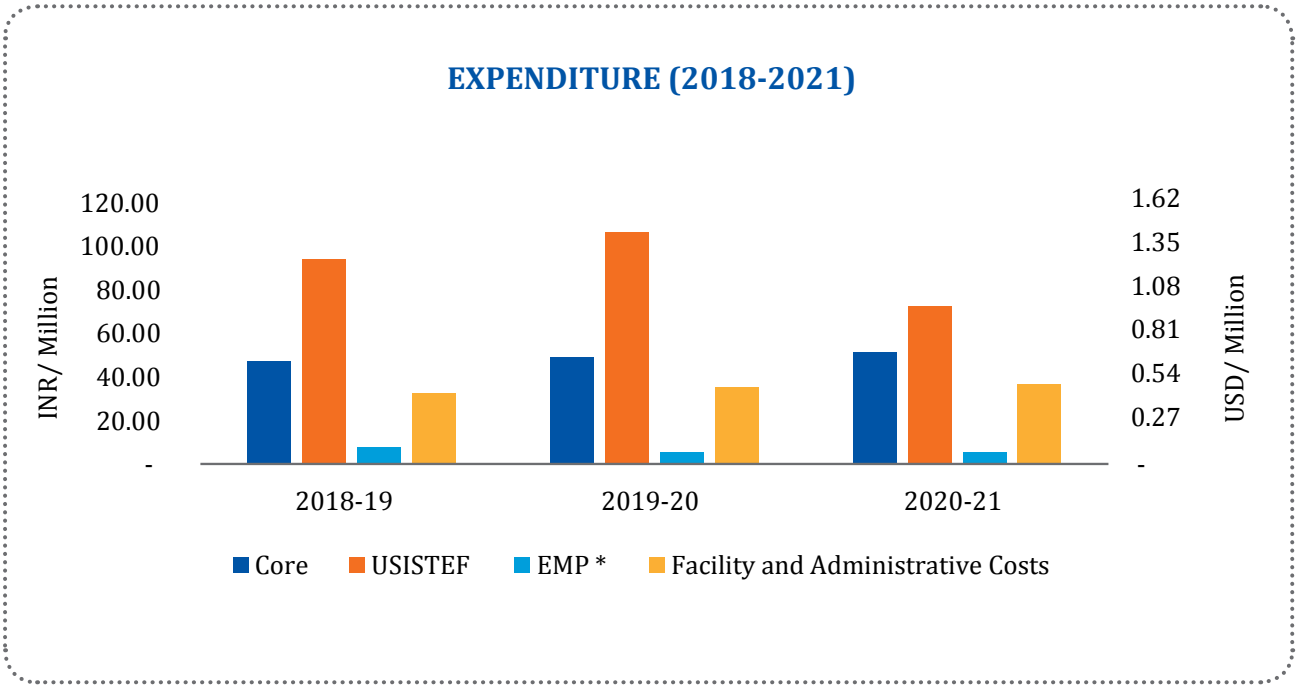
(B) Overall Expenditure

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	Core	45.18	0.61	45.59	0.62	50.67	0.68
2	USISTEF	94.37	1.28	101.54	1.37	88.91	1.20
3	EMP *	6.13	0.08	5.18	0.07	5.39	0.07
4	Facility and Admin-istrative Costs	35.38	0.48	37.03	0.50	38.44	0.52
TOTAL		**181.06**	**2.45**	**189.34**	**2.56**	**183.40**	**2.48**

** EMP income exclude targeted funds received from the funding agencies*
I USD= 74 INR



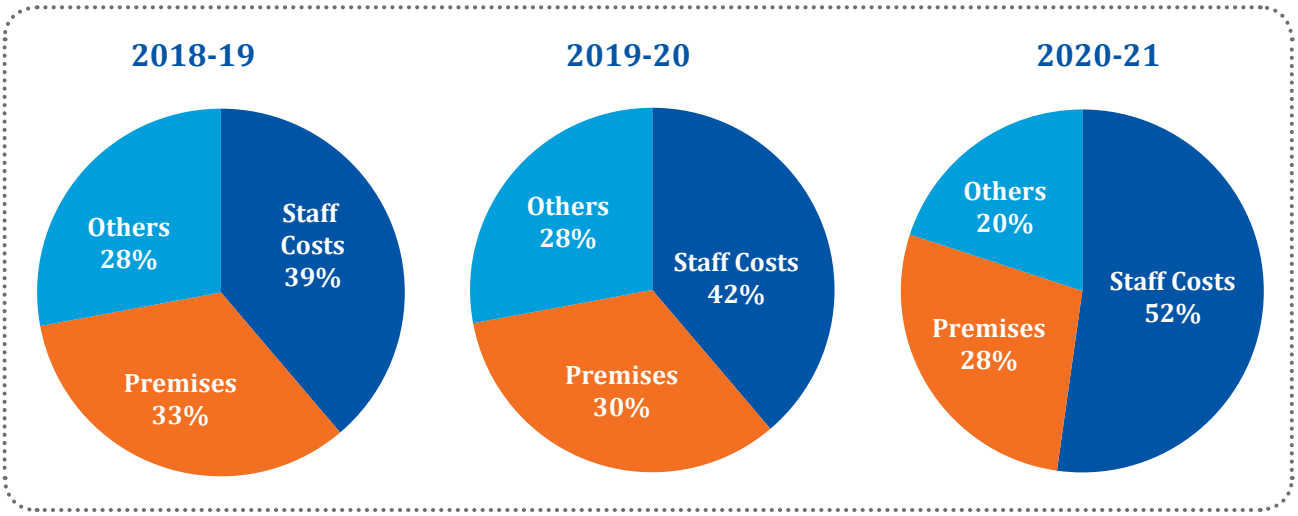

2020-21
Facility and Administrative Costs 21%
Core 28%
EMP * 3%
USISTEF 48%

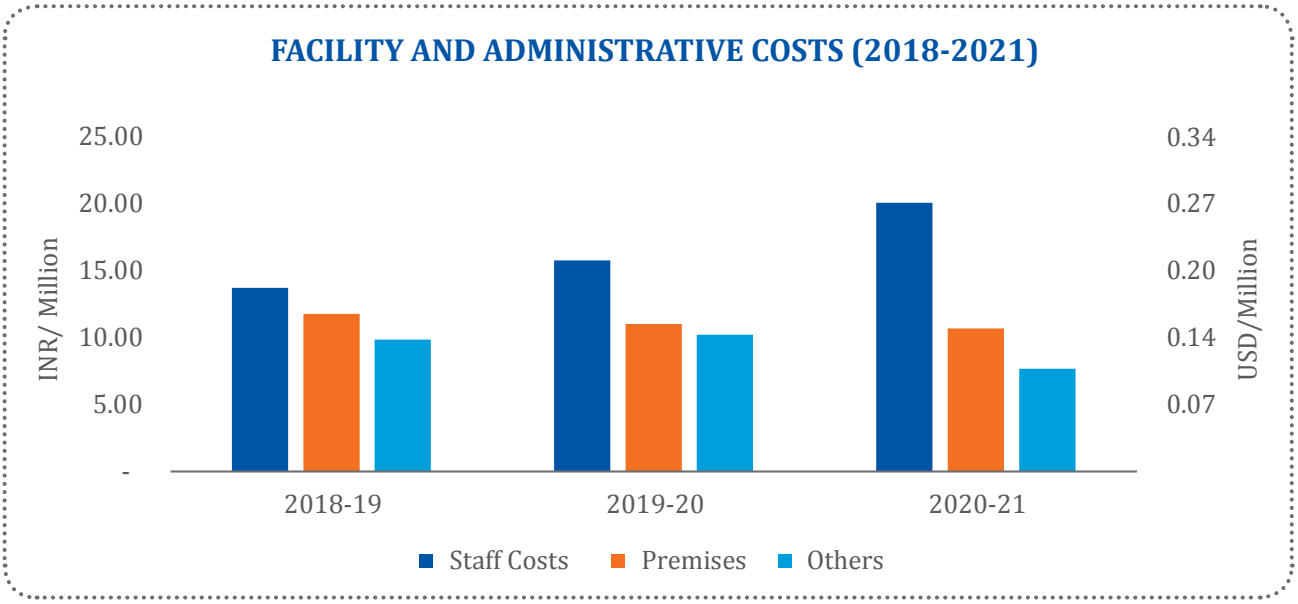

EXPENDITURE (2018-2021)
INR/ Million
120.00
100.00
80.00
60.00
40.00
20.00
-
1.62
1.35
1.08
0.81
0.54
0.27
-
USD/ Million
2018-19
2019-20
2020-21
Core
USISTEF
EMP *
Facility and Administrative Costs

(C) Facility and Administrative Costs (2018-2021)

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	Staff Costs	13.72	0.19	15.77	0.21	20.08	0.27
2	Premises	11.78	0.16	11.04	0.15	10.69	0.14
3	Others	9.88	0.13	10.22	0.14	7.68	0.10
TOTAL		**35.38**	**0.51**	**37.03**	**0.51**	**38.44**	**0.52**

I USD= 74 INR

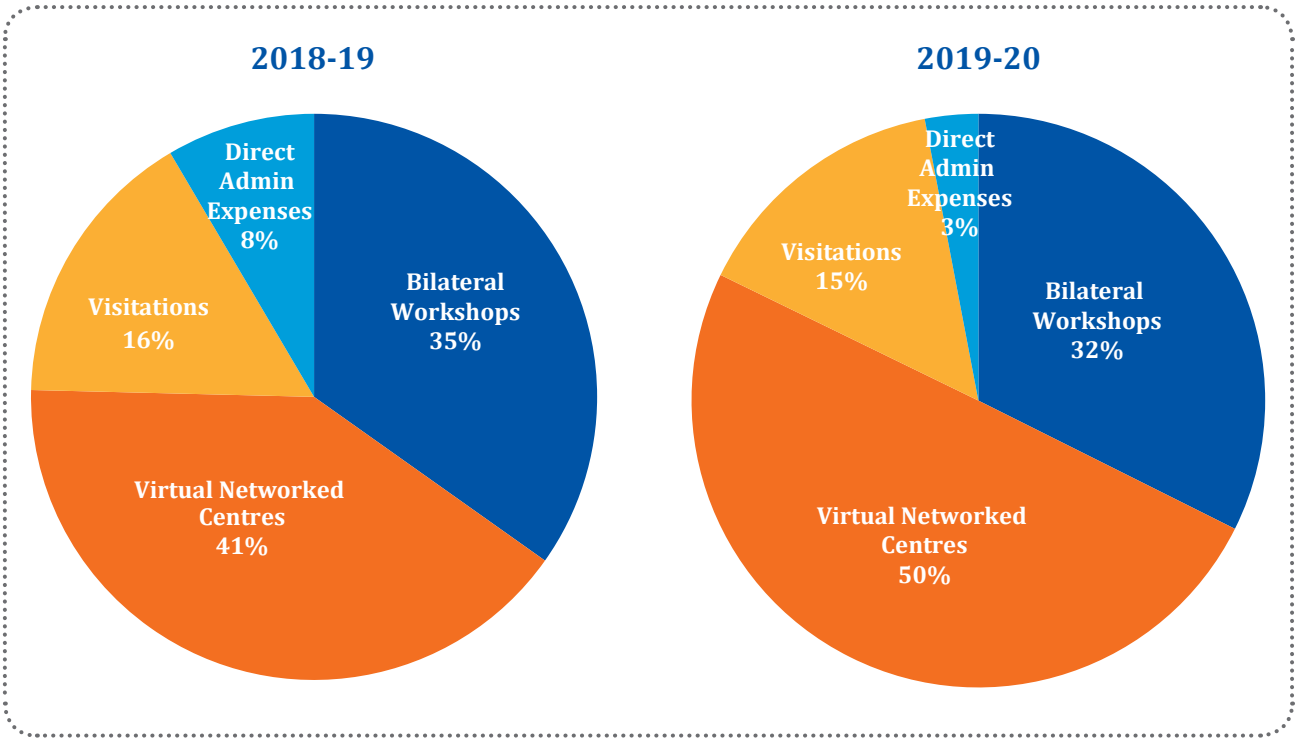


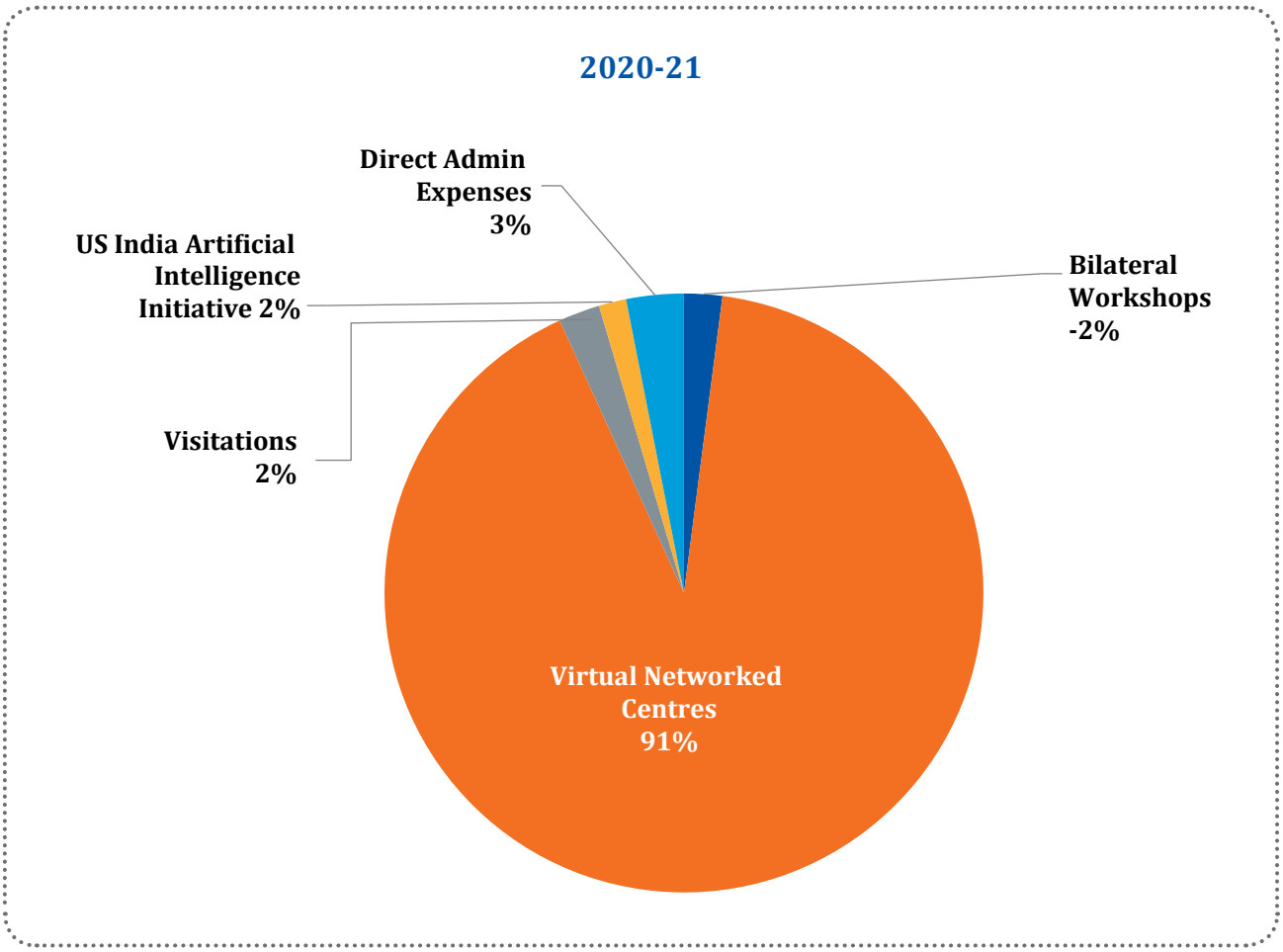


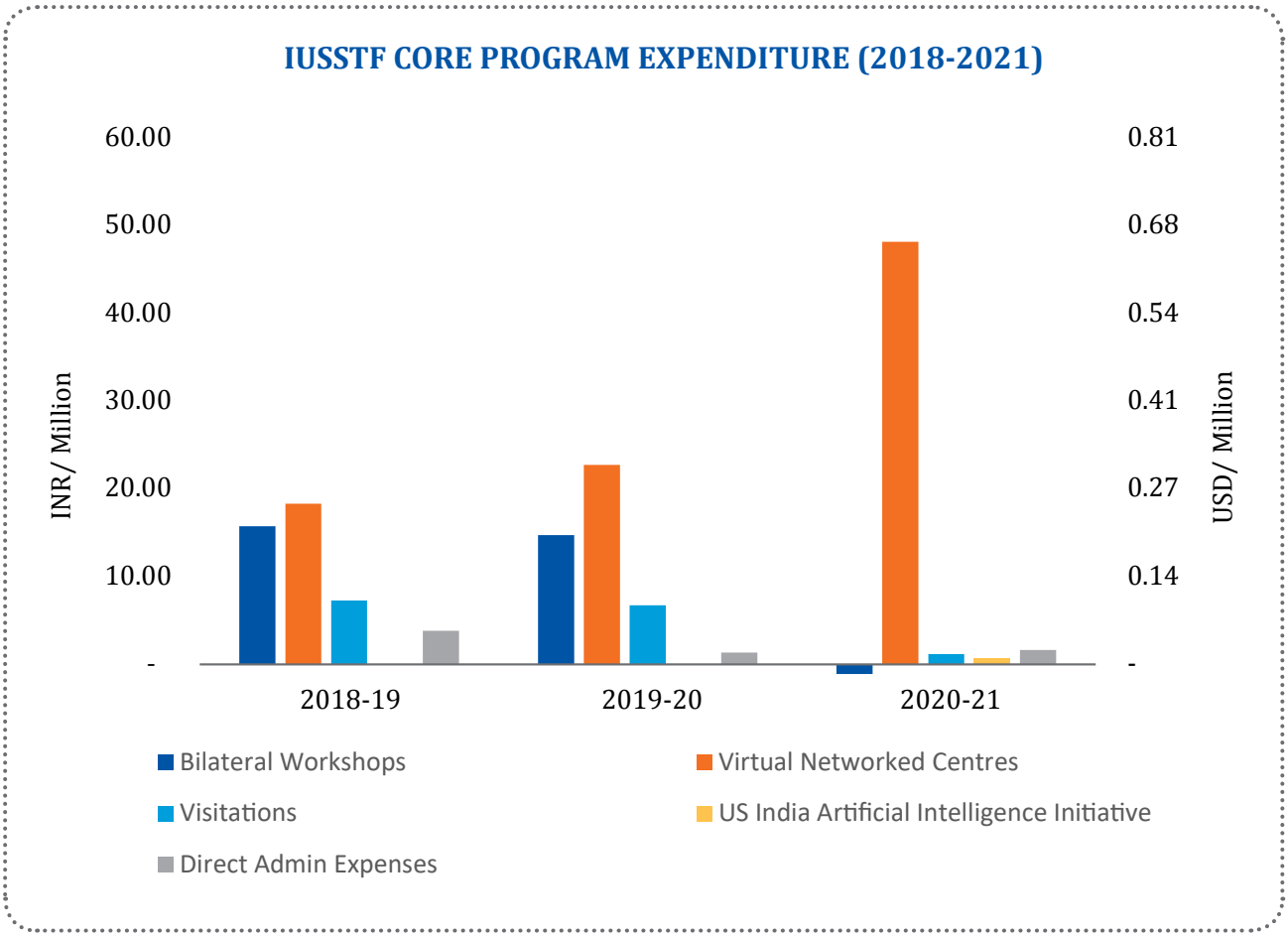
(D) Expenditure - IUSSTF Core Programs (2018-2021)

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	Bilateral Workshops	15.73	0.21	14.76	0.20	-1.09	- 0.01
2	Virtual Networked Centres	18.33	0.25	22.72	0.31	48.16	0.65
3	Visitations	7.29	0.10	6.74	0.09	1.18	0.02
4	USIAI Initiative	-	-	-	-	0.78	0.01
5	Direct Admin Expenses	3.83	0.05	1.37	0.02	1.64	0.02
	a) Governing Body Meetings	2.70	0.04	0.74	0.01	0.36	0.00
	b) Foundation Day Expenses	-	-	-	-		-
	c) Outreach Expenses etc	1.13	0.02	0.63	0.01	1.27	0.02
TOTAL		**45.18**	**0.61**	**45.59**	**0.63**	**50.67**	**0.68**

I USD= 74 INR


2018-19
Direct Admin Expenses 8%
Bilateral Workshops 35%
Visitations 16%
Virtual Networked Centres 41%
2019-20
Direct Admin Expenses 3%
Visitations 15%
Bilateral Workshops 32%
Virtual Networked Centres 50%

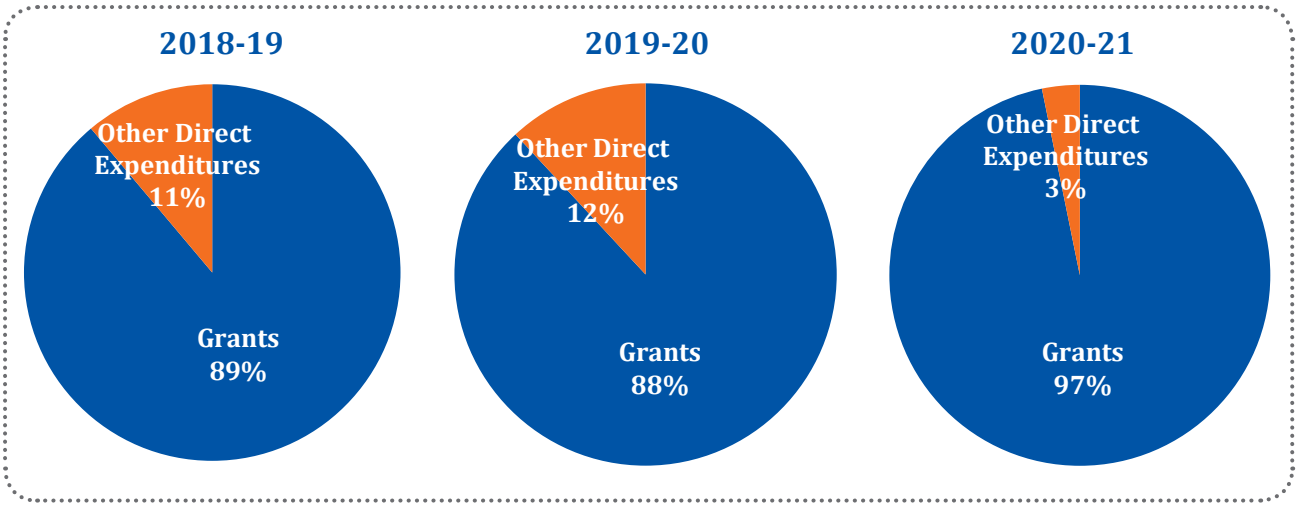

2020-21
Direct Admin Expenses 3%
US India Artificial Intelligence Initiative 2%
Bilateral Workshops -2%
Visitations 2%
Virtual Networked Centres 91%

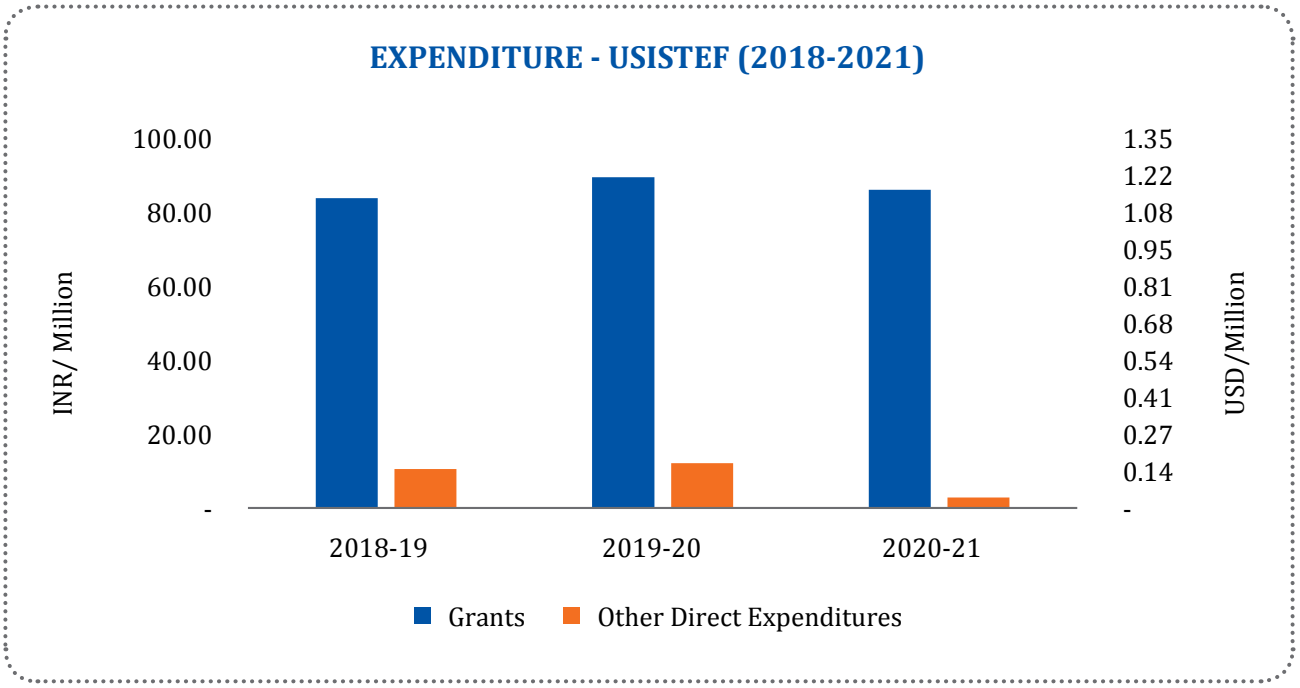

IUSSTF CORE PROGRAM EXPENDITURE (2018-2021)
60.00
50.00
40.00
30.00
20.00
10.00
-
INR/ Million
0.81
0.68
0.54
0.41
0.27
0.14
-
USD/ Million
2018-19
2019-20
2020-21
Bilateral Workshops
Virtual Networked Centres
Visitations
US India Artificial Intelligence Initiative
Direct Admin Expenses

(E) Expenditure - USISTEF

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	Grants	83.86	1.13	89.45	1.21	86.07	1.16
2	Other Direct Expenditures	10.51	0.14	12.09	0.16	2.84	0.04
TOTAL		**94.37**	**1.28**	**101.54**	**1.37**	**88.91**	**1.20**

I USD= 74 INR

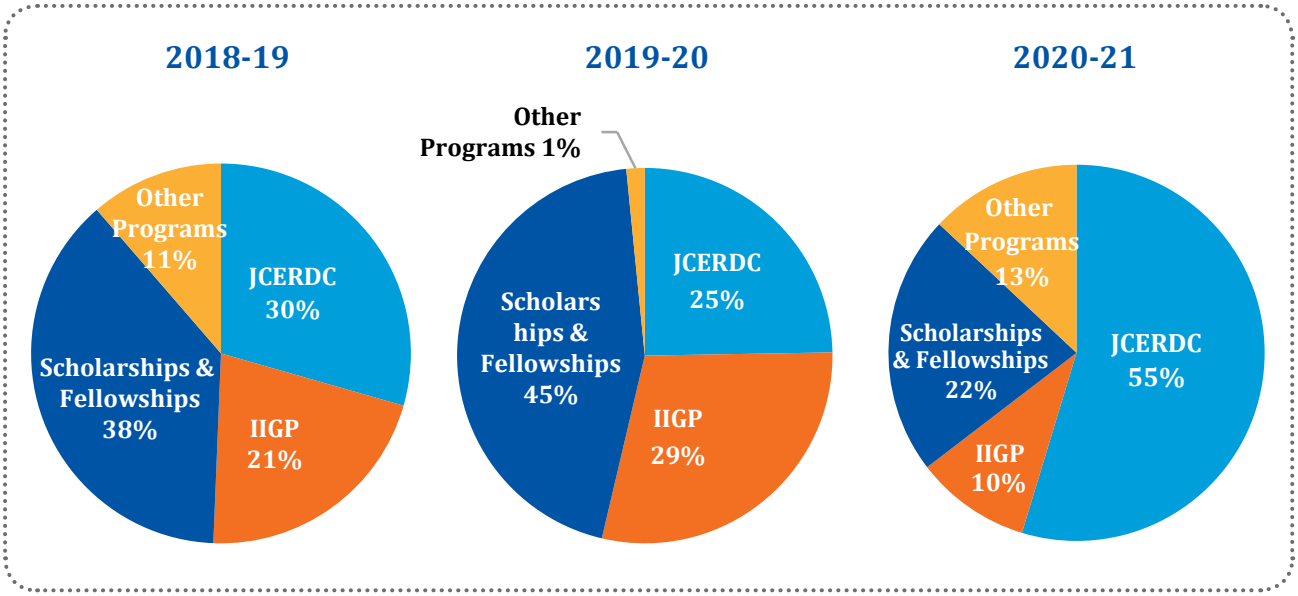


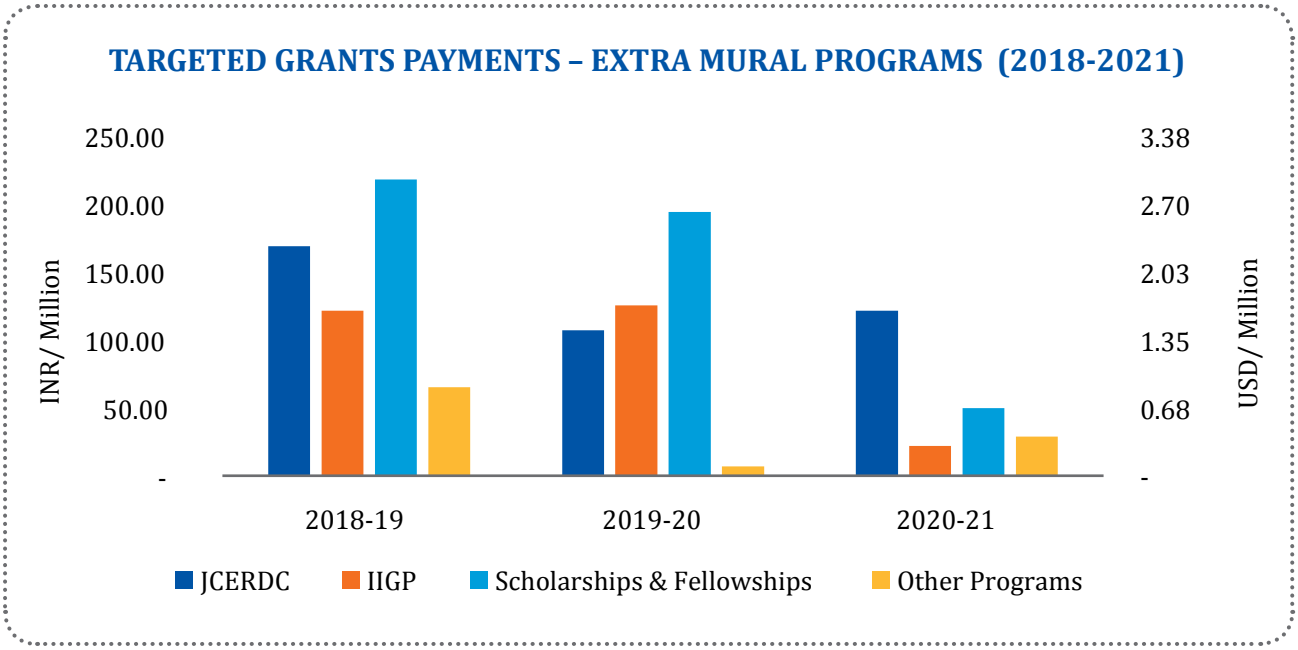


(F) Targeted Grants Payments - Extra Mural Programs

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	JCERDC	168.85	2.28	107.29	1.45	121.70	1.64
2	IIGP	121.65	1.64	125.62	1.70	22.07	0.30
3	Scholarships & Fellowships	218.02	2.95	194.15	2.62	49.80	0.67
4	Other Programs	65.10	0.88	6.85	0.09	28.97	0.39
TOTAL		**573.62**	**7.75**	**433.91**	**5.86**	**222.53**	**3.01**

I USD= 74 INR

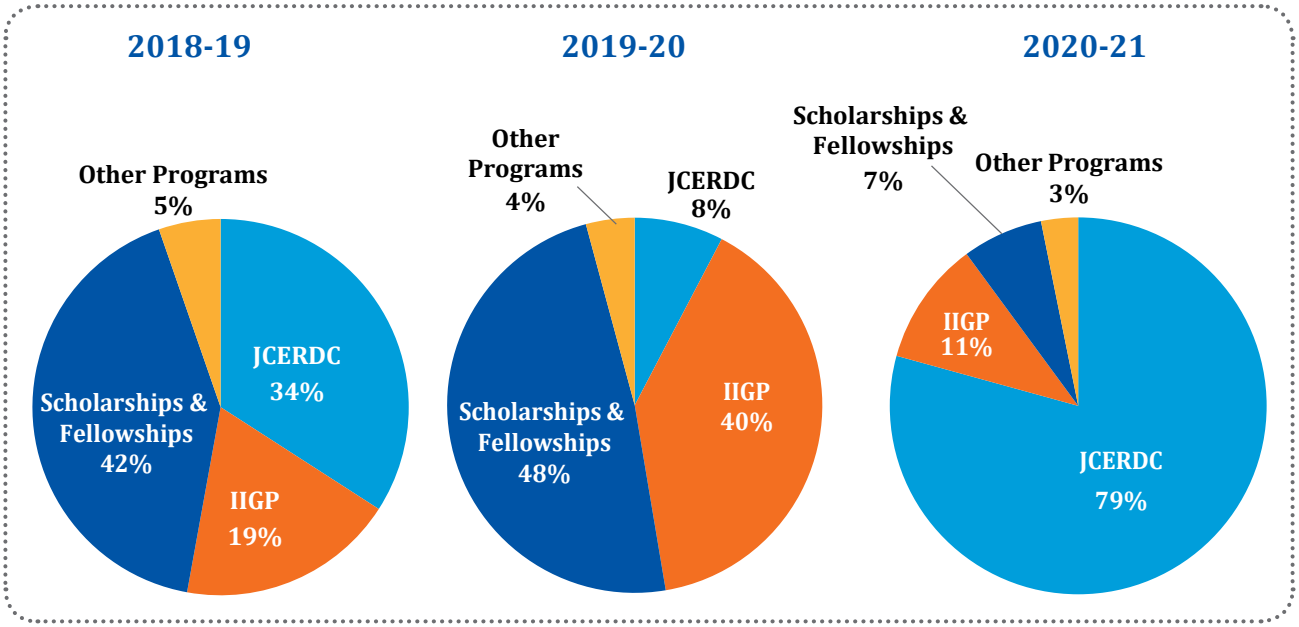


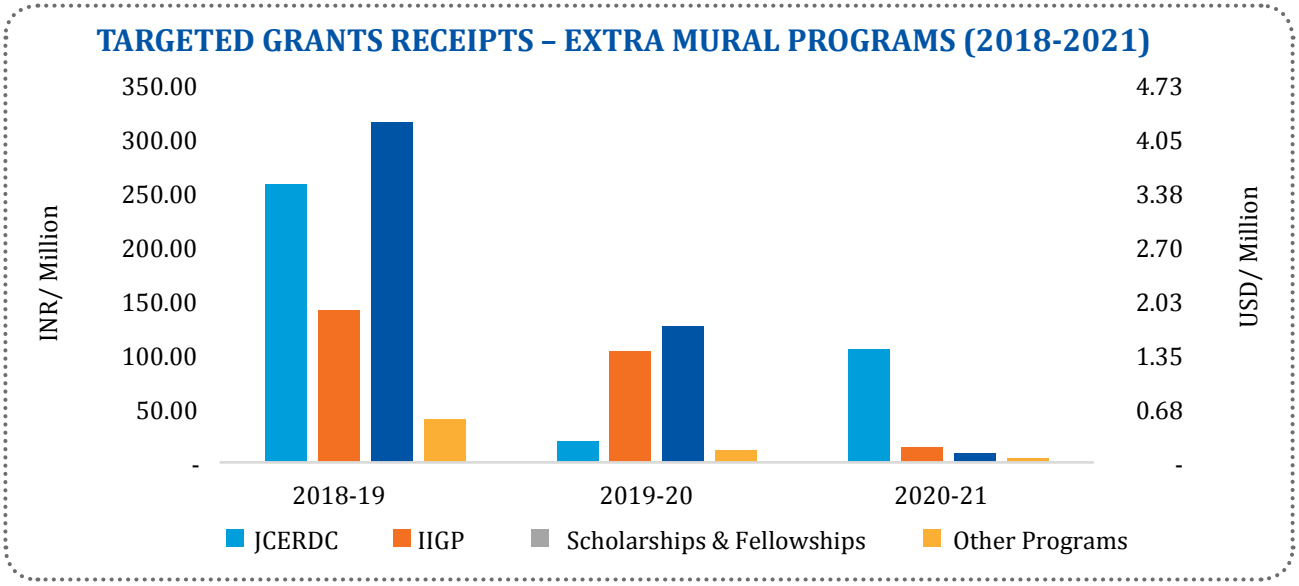


(G) Targeted Grants Receipts - Extra Mural Programs

S.No	Head	2018-19		2019-20		2020-21	
		(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)	(INR/ Million)	(USD/ Million)
1	JCERDC	257.05	3.47	20.01	0.27	105.14	1.42
2	IIGP	141.32	1.91	103.42	1.40	14.10	0.19
3	Scholarships & Fellowships	315.27	4.26	126.29	1.71	9.17	0.12
4	Other Programs	40.06	0.54	10.93	0.15	4.21	0.06
TOTAL		**753.70**	**10.19**	**260.66**	**3.52**	**132.63**	**1.79**

I USD= 74 INR





Section VII:
Annexures

Annexure I

A. The list of projects under the **U.S. India Science and Technology Endowment Fund (USISTEF)** reviewed during the meeting held on 27th May 2020 via videoconference

S. No	Proposal Title	Indian PI(s)	U.S. PI(s)
1.	*MIRACLE Dialysis - Wearable Alternate Kidney*	**Gowrishankar Wuppuluru** Padmaseetha Technologies Pvt. Ltd., Chennai	**Beth Kolko** Shift Labs, Seattle
	ArmAble: An Interactive Arm Training Rehabilitation Device	**Habib Ali** BeAble Health Pvt Ltd. Indian Institute of Technology Hyderabad	**Ramana Kumar Vinjamuri** Stevens Institute of Technology, Hoboken
2.	*Commercialization of Advanced Multi-layer Wound Dressing for Accelerated Healing and Infection Prevention of Indian Diabetic Foot Patients*	**Vijay Viswanathan** MV Hospital for Diabetes and Prof M. Viswanathan Diabetes Research Centre, Chennai	**Ashwinraj Karthikeyan** InMEDBio LLC, Neenah
3.	*Lab-on-a-strip (LOS) : Towards Multi-analyte Screen Printed Biosensor Strips*	**Vinay Kumar** PathShodh Healthcare Pvt. Ltd., Bengaluru	**Erik Sventeckis** GSI Technologies, Burr Ridge
4.	*GaN based High Power LNA for 5G Applications*	**Yogesh Singh Chauhan** Indian Institute of Technology, Kanpur	**Amitava Das** Tagore Technology Inc., Arlington Heights

B. The following project was reviewed during the meeting held on 29th June 2020 via videoconference

S. No	Proposal Title	Indian PI(s)	U.S. PI(s)
1.	*Low Cost, Anti-counterfeiting Labels*	**Deepak Gupta** Indian Institute of Technology, Kanpur **Pranav Asthana, Founder** Transpacks Technologies Pvt. Ltd., Kanpur	**Sudhanshu Bahadur** Ampora LLC, Cupertino

Annexure II

The following Projects awarded under the previous calls of the **U.S. India Science and Technology Endowment Fund (USISTEF)** have been successfully closed:

S. No.	Project Title	Indian PI	U.S. PI
1.	Handheld Forced Oscillation Device for Improved Detection and Monitoring of Airway Diseases	**Anurag Agarwal** CSIR-Institute of Genomics & Integrative Biology (IGIB), New Delhi	**Ashutosh Sabharwal** Cognita Labs and Rice University, Houston **Gaurav Patel** Cognita Labs LLC, Houston
2.	Lightweight, Ultra-Fast, Next-Generation Magnetic Resonance Imaging (MRI) Scanners	**Arjun Arunachalam** Voxelgrids Innovations Pvt. Ltd., Bangalore	**Shahin Pourrahimi** Superconducting Systems Inc., Billerica
3.	Wireless Sensor-based Wearable Device for Heart Disease Management	**Ravi Bhogu** Monitra Healthcare Pvt. Ltd., Hyderabad	**Joseph S. Menezes** DuPont, Sunnyvale, CA

Annexure III

Streaming Analytics over Temporal Variables from Air quality Monitoring (SATVAM) Project

a) Power Harvesting

- MK Sharma, Jishnu Bhattacharya*, A novel stationary concentrator to enhance solar intensity with absorber-only single axis tracking, Renewable Energy, 154, 976-985, 2020

b) Sensor Calibration

- Sahu, R., Kuldeep K. Dixit, S.N. Tripathi et al., Validation of low-cost sensors in measuring real-time PM10 concentration at two sites in Delhi National Capital Region, Sensors, 20, 1347, DOI::10.3390/s20051347, 2020.
- Zheng, T., S.N. Tripathi et al., Gaussian Process regression model for dynamically calibrating and surveilling a wireless low-cost particulate matter sensor network in Delhi, Atmospheric Measurement and Techniques, 12(9), 5161–5181, DOI: 10.5194/amt-12-5161-2019, 2019.
- Zhang, S.Y., S.N. Tripathi et al., Intensive allochthonous inputs along the Ganges River and their effect on microbial community composition and dynamics, Environmental Microbiology, 21(1), 182-196, DOI: 10.1111/1462-2920.14439, 2019.

c) Networking

a) Simmhan, Y., Nair, S., Monga, S., Sahu, R., Dixit, K., Sutaria, R., Mishra, B., Sharma, A., SVR, A., Hegde, M., Zele, R., and Tripathi, S.N. "SATVAM: Toward an IoT Cyber-Infrastructure for Low-Cost Urban Air Quality Monitoring," 2019 15th International Conference on eScience (eScience), San Diego, CA, USA, 2019, pp. 57-66. DOI: 10.1109/eScience.2019.00014

b) Manuscript submitted: Sahu, R., S. N. Tripathi et al., Robust statistical calibration and characterization of portable low-cost air quality monitoring sensors to quantify real-time O3 and NO2 concentrations in diverse environments, 2020.

Annexure IV

Design and Development of Aquatic Autonomous Observatory (Niracara Svayamsasita VedhShala - NSVS) for In situ Monitoring, Real Time Data Transmission and Web based Visualization

- Indian Patent Application No. - 201911041227: "Apparatus and Method for Real-Time, In-Situ Monitoring of Water Quality",
- Inventors – Pawandeep Singh Matharu and Prof. Bishakh Bhattacharya. (2019)
- Matharu P.S., Singh R., Nayak S.P., Bhattacharya B. and Kothari M. (2020) "Analysis, Design and Development of River/Water Quality Monitoring Buoy with Hybrid Energy Harvesters", Submitted to Journal of Environmental Monitoring and Assessment (Springer).
- Piezoelectric vortex induced vibration energy harvesting in a random flow field (2020) Sondipon Adhikari, Akshat Rastogi and Bishakh Bhattacharya, Smart Materials and Structures,Volume 29, Number 3.
- Study of piezo embedded negative mass metamaterial using generalized Bloch theorem for energy harvesting system (2019), A Dwivedi, A Banerjee, B Bhattacharya, Proceedings of the SPIE, Volume 10967, DOI: 10.1117/12.2514248.
- Simultaneous energy harvesting and vibration attenuation in piezo-embedded negative stiffness metamaterial (2020) A Dwivedi, A Banerjee, B Bhattacharya - Journal of Intelligent Material Systems and Structures, DOI: 10.1177/1045389X20910261
- Wang, Z. A., H. Moustahfid, A. V. Mueller, A. P. M. Michel, M. Mowlem, B. T. Glazer, T. A. Mooney, W. Michaels, J. S. Mcquillan, J. C. Robidart, J. Churchill, M. Sourisseau, A. Daniel, A. Schaap, S. Monk, K. Friedman, and P. Brehmer. 2019. Advancing Observation of Ocean Biogeochemistry, Biology, and Ecosystems With Cost-Effective in situ Sensing Technologies. Frontiers in Marine Science 6.
- R. Dixit, A. S. Bedi, R. Tripathi, and K. Rajawat, "Online Learning with Inexact Proximal Online Gradient Descent Algorithms," IEEE Transactions on Signal Processing, vol. 67, no. 5, pp. 1338-1352, Mar. 2019.

Annexure V

Integrated low-cost water sensors for real- time river water monitoring and decision- making

a) RV1: Sensor development (Publications)

- Sedki,M., Chen, X., Chen,C., Ge, X., and Mulchandani,A. 2020. Non-lytic M13 phagebased highly sensitive impedimetric cytosensor for detection of coliforms. Biosensors and bioelectronics. 148-111794. https://doi.org/10.1016/j.bios.2019.111794
- Kaabir Ali (2019) fabrication and integration of microfluidic platform for fluorimetric analysis. M.Tech. Dissertation Jamia Millia Islamia and Indian Institute of Technology Delhi
- Jayant Kalra (2019) Lab-on-a-chip chemical oxygen demand sensor. M.Tech. Dissertation Jamia Millia Islamia and Indian Institute of Technology Delhi

b) RV2: Energy harvesting (Publications)

- Investigation of anomalous behavior in J-V and Suns-Voc characteristics of carrier selective contact silicon solar cells; M. Nayak, S. Mudgal, S. P. Singh and V K Komarala; Solar Energy 201 (2020) 307.
- Nickel oxide hole-selective heterocontact for silicon solar cells: Role of SiOx interlayer on device performance;M. Nayak, S. Mandal, A. Pandey, S. Mudgal, S. P. Singh and K. Komarala;Solar Rapid Research Letters 3 (2019) 200261.
- Effect of textured silicon pyramids size and chemical polishing on the performance of carrier-selective contact heterojunction solar cells;K. Singh, M. Nayak, S. Mudgal, S. P. Singh and V K Komarala;Solar Energy 183 (2019) 469.
- Carrier-selective based silicon solar cells processed at room temperature using industrially feasible Cz wafers;M. Nayak, K. Singh, S. Mudgal, S. Mandal, S. P. Singh and V K Komarala;Physica Status Solidi A 216 (2019) 1900208. [Article appeared under Hot Topic: Solar cells; as original paper on Wiley Online Library website: doi/toc/10.1002/(ISSN)1614-6840.hottopic-solarcells]
- Electrical characterization and defect states analysis of Ag/ITO/MoOx/n-SI/LiFx/Al carrier-selective contact silicon solar cells processed at room-temperature M. Nayak, S. Mudgal, S. Mandal, S. Singh and V. K. Komarala 9th International Conference on Crystalline Silicon Photovotlaics (in Leuven, Belgium) ;American Institute of Physics Conference Proceedings 2147 (2019) 040014
- Feasibility study of renewable resources based hybrid system for water quality sensors load applications in remote location;M. Alam and V. Dutta (Under Review for International Journal)

- Characterization and defect states analysis of Ag/ITO/MoOx/n-SI/LiFx/Al carrier selective contact silicon solar cells processed at room-temperature M. Nayak, S. Mudgal, S. Mandal, S. Singh and V. K. Komarala , 9th International Conference on Crystalline Silicon Photovoltaics (in Leuven, Belgium) . American Institute of Physics Conference Proceedings 2147 (2019) 040014.
- Towards high Voc, thin film, homojunction WS2 solar cells for energy harvesting applications. Koosha Nassiri Nazif, Aravindh Kumar, Maria Thereza Moreira de Menezes, and Krishna Saraswat, Proc. SPIE 11126, Wide Bandgap Materials, Devices, and Applications IV, 1112606 (6 September 2019); https://doi.org/10.1117/12.2533007
- Contact Selectivity Engineering in 2 μm Thick Ultrathin c-Si Solar Cell using Transition Metal Oxides Achieving Efficiency of 10.8%. Muyu Xue, R. Islam, A. Meng, Z. Lyu, C.- Y. Lu, Ching-Ying; C. Tae, M. Braun, K. Zang, P. McIntyre, T. Kamins, K. Saraswat, J. Harris, ACS Applied Materials & Interfaces (Accepted).
- Free-standing 2.7 μm Thick Ultrathin Crystalline Silicon Solar Cell with Efficiency above 12.0%. Muyu Xue, K. N. Nazif , Z. Lyu, J. Jiang, C.-Y. Lu, N. Lee, K. Zang, Y. Chen, T. Zheng, T. I. Kamins, M. L. Brongersma, K. C. Saraswat, J. S. Harris, Nano Energy, (Accepted)

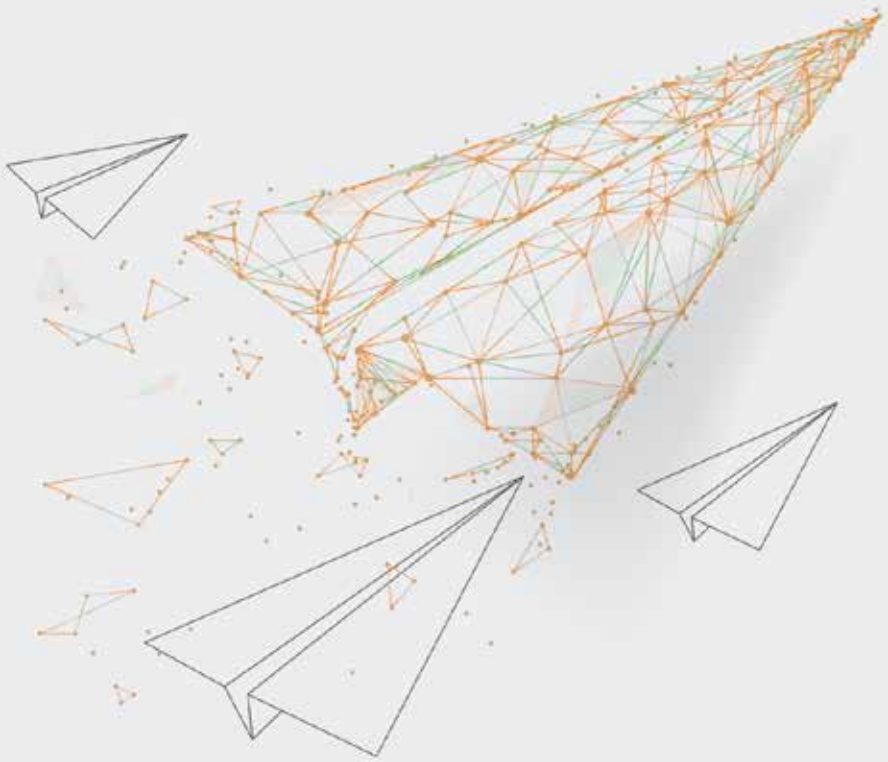
c) RV3:Sensor networking(Publications)

- Ajit K Sahoo, Siba K Udgata, "A Novel ANN Based Adaptive Ultrasonic Measurement System for Accurate Water Level Monitoring", IEEE Transactions on Instrumentation and Measurements, Available online on 9th September 2019.
- Mohanty, S.K. and Udgata,S.K. 2020. Minimizing the maximum receiver interference in wireless sensor networks using a probabilistic interference model. Engineering Applications of Artificial Intelligence. 91:103563.
- Javvaji.G. and Udgata,S.K. 2020. Soft computing approach for multi-objective task allocation problem in wireless sensor network. Evolutionary Intelligence. In press.
- RV4:Field monitoring and validation(Publications)
- Neha Tyagi, Arun Kumar, Sandeep Jha, Vivekanandan Perumal, Joan B Rose, Ashok Mulchandani. Understanding challenges in conducting QMRA of pathogen exposure from Yamuna river water using sensor based data (Society for Risk Analysis-2019, Virginia, Arlington, US).

Patents

- Room temperature processed dopant-free carrier selective contact based silicon solar cells on unheated silicon wafers . V K. Komarala, M. Nayak, K. Singh, S. Mandal, and S. P. Singh ;Indian Patent Application No: 201811017912.
- Indian patent: Difference based data aggregation and recovery, Arun Avinash Chouhan, 201941000211, filing data:02-01-2019, in process.

Notes



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