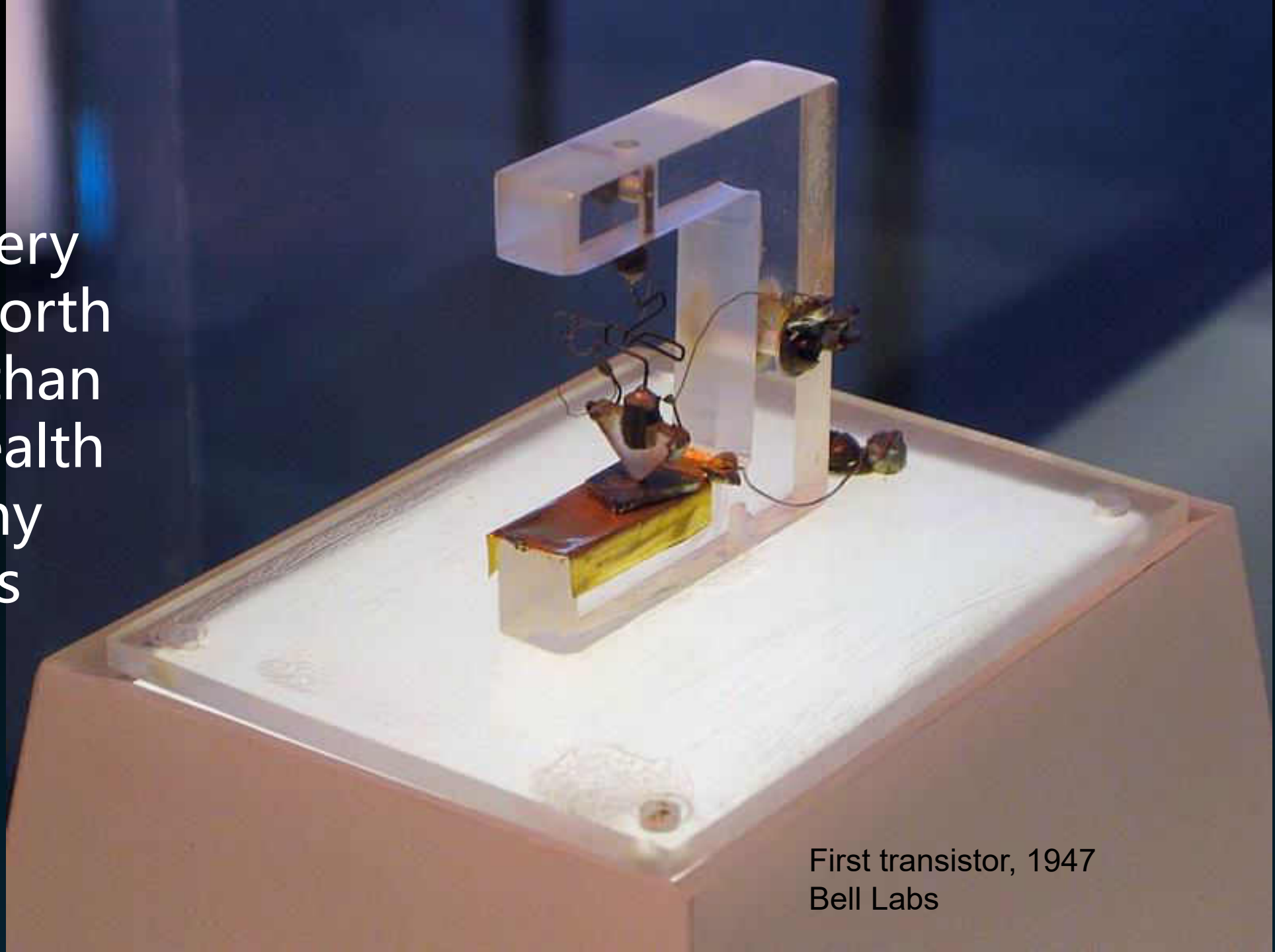
Empowering India

Ideas for Action by Scientists and Engineers

Thalappil Pradeep and Krishnan Narayanan

One discovery may worth more than the wealth of many nations

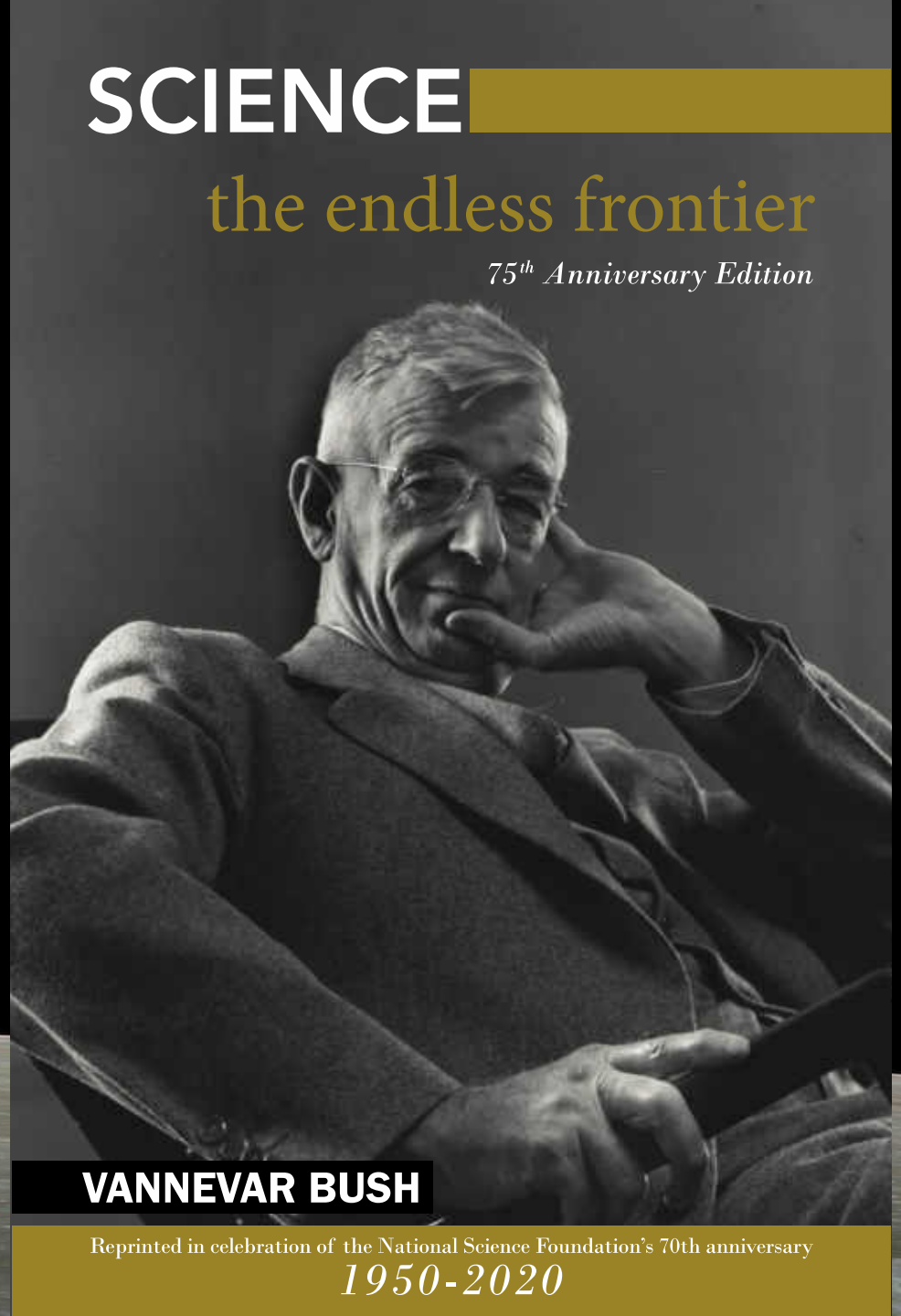


First transistor, 1947
Bell Labs

Science

IS THE

Future



Universities built the world through science

Image from *Wikipedia*

Knowle

he world

Imagining India - 2047

It is 2047. India is among the top 3 economies in the world. It is also in the top 3 nations in research, and technologies like AI, EV and green hydrogen, and spends 3% of its GDP on R&D. It is in top 10 in the Global Innovation Index, has achieved Gross Enrolment Ratio of over 50%, and Human Development Index of 0.9.

This dream is POSSIBLE. It can become a reality.

Key Messages of Empowering India

1. Science, technology, arts and innovation (STAI) have a central role in ensuring a spectacular future for India

#STAI4EmpoweringIndia

2. STAI has an important responsibility and role in achieving an equitable, inclusive and holistic development of the country

#STAI4All

3. STAI has to find solutions to overcome the world's consumption intensity and resource-dependence, and the adverse effects of climate change which pose existential threats to life on Earth

#STAI4SustainableDevelopment

Key Messages of Empowering India

4. Indian STI ecosystem must find the sweet spot of use-inspired research

#STI4UseInspiredResearch

5. Indian research must be multi-disciplinary and be benchmarked against the best in the world

#GloballyCompetitiveResearch

6. Just like entrepreneurship, Indian research too must be made attractive to the brightest students and faculty from India and the world

#MakeResearchAttractive

Key Messages of Empowering India

7. Indian STI should create more deep-tech startups that leverage cutting-edge sciences & technologies to solve the toughest industrial and social challenges

#DeeptechStartups

8. India should embrace digital learning and innovative educational practices to once again become a 'global leader' in science and technology

#BeEduGlobalLeader

9. Skilling and reskilling of Indian talent needs to bear in mind that this talent services two distinct needs – the needs of an increasingly digitalized world and the social entrepreneurship needs of the hinterlands of India

#ReskillIndia4World

10. We visualized India in the coming decades through the eyes of scientists and engineers. We also need them to be poets and artists. We also need them to be anthropologists and sociologists. We need them to be humans first.

#HumanityBeforeTechnology

A brief history of S&T in India

S&T in ancient India

Science and technology

- In mathematics, decimal value system, zero, calculus, and trigonometry
- Indian brick and metal (esp. iron) technology is thousands of years old
- Ayurveda in medicine and wellness

Education

- Ancient schools of learning and knowledge creation
- The school at Takshashila or Takshila produced great scholars like Panini, Charaka, and Chanakya
- The Nalanda University, established in the early fifth century, is likely to be the oldest university in the world

The great Anicut of 150 CE due to Chola dynasty in the background

S&T in princely states and British India

In this period, India witnessed promotion of diverse fields such as art, culture, industry, irrigation, textiles, tourism, education and research.

Princely states

- Mysore – IISc, University of Mysore
- Travancore – supported Ayurveda, agriculture
- Baroda – free primary, and female education

Educational institutions

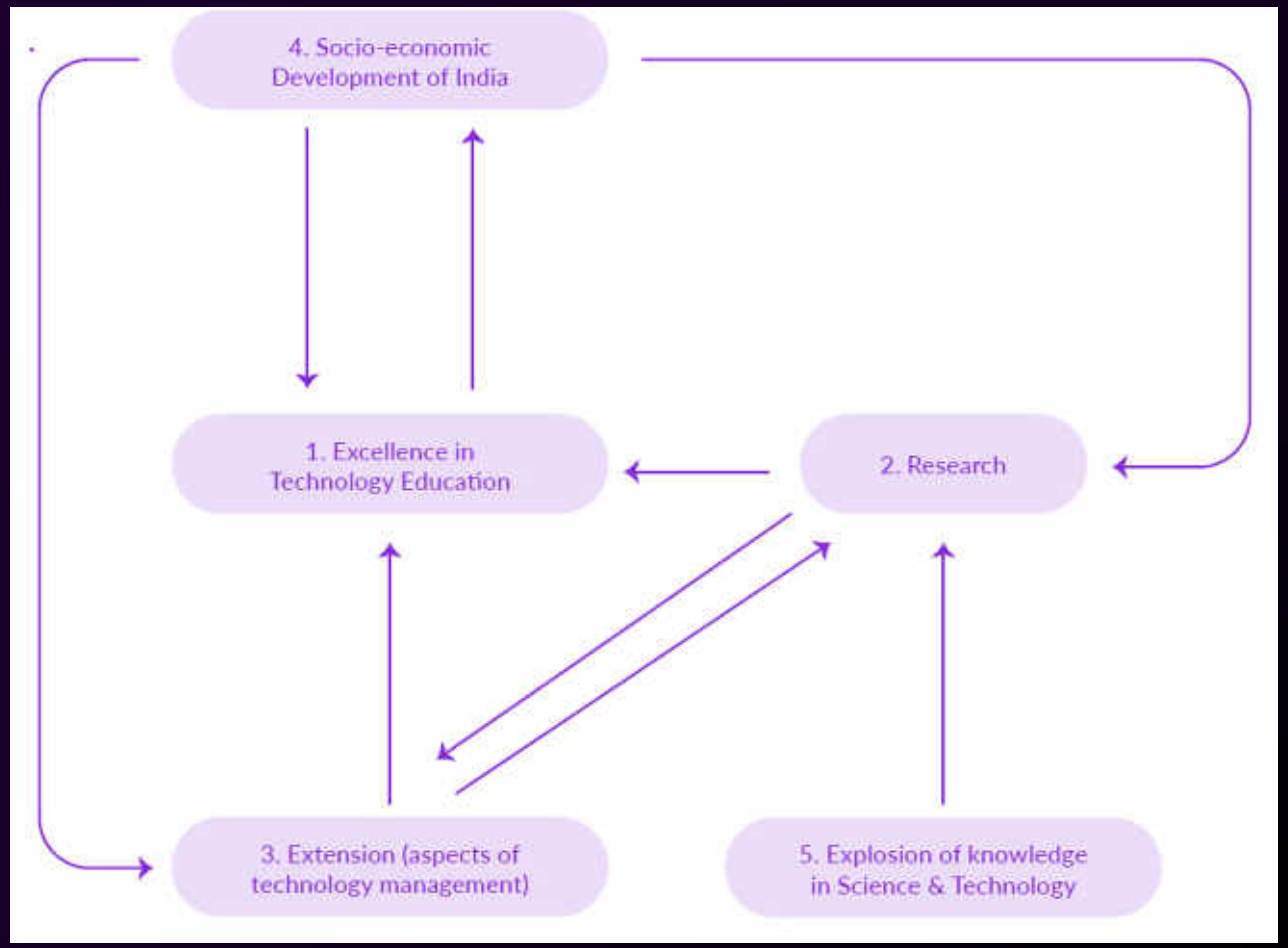
- Roorkee College (1847)
- Jadavpur University (1906)
- Banaras Hindu University (1916)

Scientific institutions

- Geological Survey of India (1851), India Meteorological Department (1875), Pusa Agricultural Institute (1903), ICAR (1929), CSIR (1942)

Indian Institute of Technology Model

The first Indian Institute of Technology was established in 1951 at Kharagpur, followed by IIT Bombay (1958), IIT Madras (1959), IIT Kanpur (1959) and IIT Delhi (1961).



Pictures of IITs / IISc

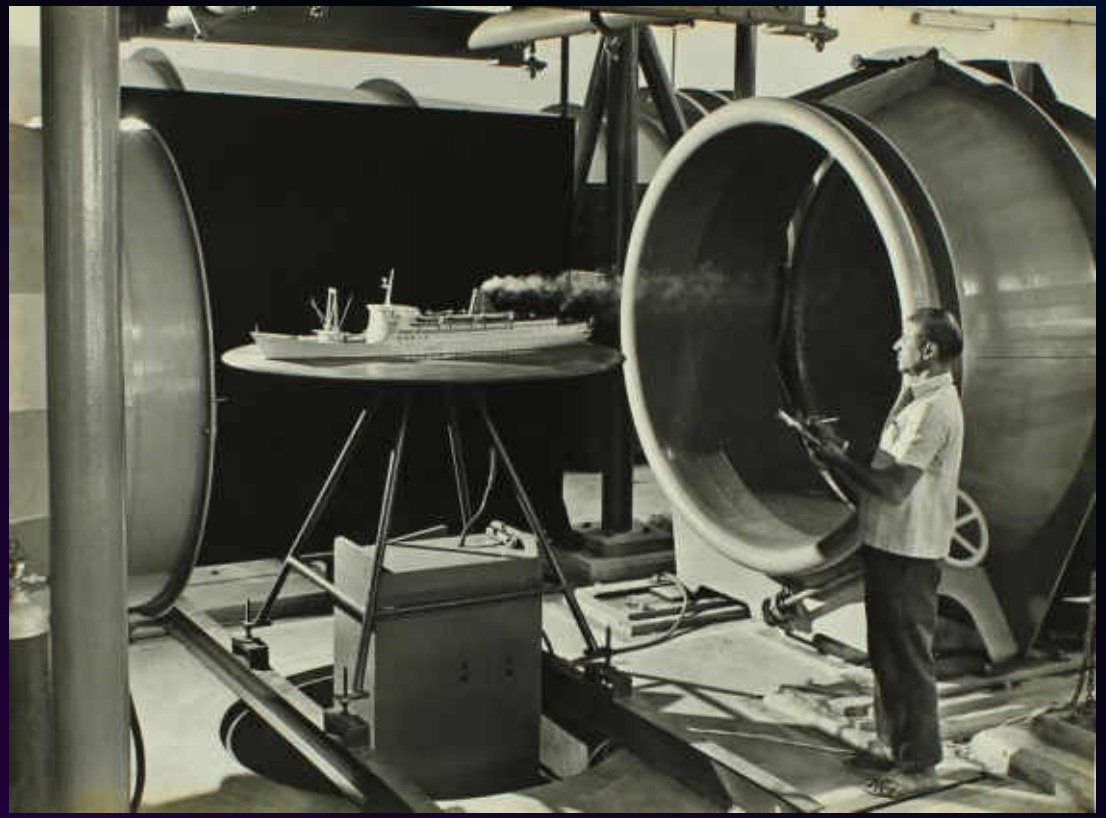
IIT Kharagpur

IISc

IIT Bombay

Pictures of IITs / IISc

IIT Kanpur



IIT Madras

IIT Delhi

National facilities for enhancing research infrastructure in the IITs

IITD	IITM	IITK	IITKGP	IITB	IITR
• National centre for upgradation of textiles education • National resource centre for value education engineering • Biotechnology information sub-centre	• Regional sophisticated instrumentation centre • Centre for computational fluid dynamics • Ocean engineering centre	• National information centre of earthquake engineering • National wind tunnel facility • Atomic force microscope • Advanced centre for materials science	• Post harvest technology centre • LSI design centre • Centre for educational technology • National facility in medical technologies • National MEMS design centre	• Geotechnical centrifuge facility • Sophisticated analytical instrumentation facility • Centre for Software validation and verification	• Thermal ionization isotope studies • Electron probe microanalysis • Shake table facility • Wind tunnel facility • Strong motion facility network

Innovative technologies developed by the IITs in their early years

Designed modern rice mills in India Paddy-husk fired combustors	Engineering tools for India's Light Combat Aircraft, Tejas	First deterministic polynomial-time algorithm for the primality testing problem	CorDECT Wireless Local Loop Clean water using advanced materials	Helped in making phased array radars in India	Work on earthquake engineering

Current state of S&T in India

Investments in R&D – country-wise

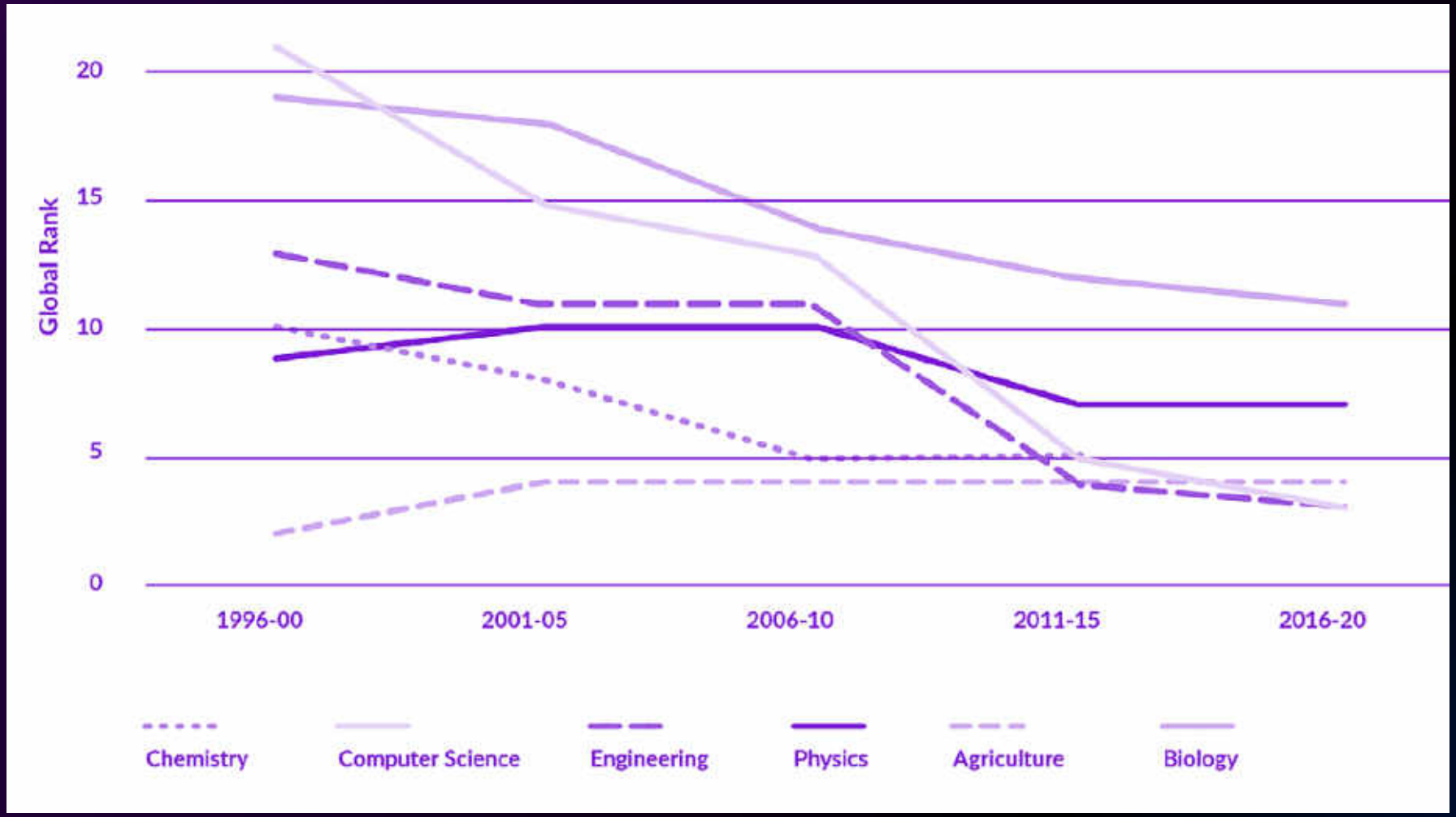
Country	R&D investment as a % of GDP	R&D in PPP (USD million)	Number of researchers per million
Brazil	1.3	40, 519	887
China	2	346, 266	1089
Malaysia	1.3	9, 280	2054
United Kingdom	1.6	43, 811	4603
Russia	1.1	40, 360	2784
United States	2.7		4412
India	0.7	47, 574	266

Private investments in R&D – country-wise

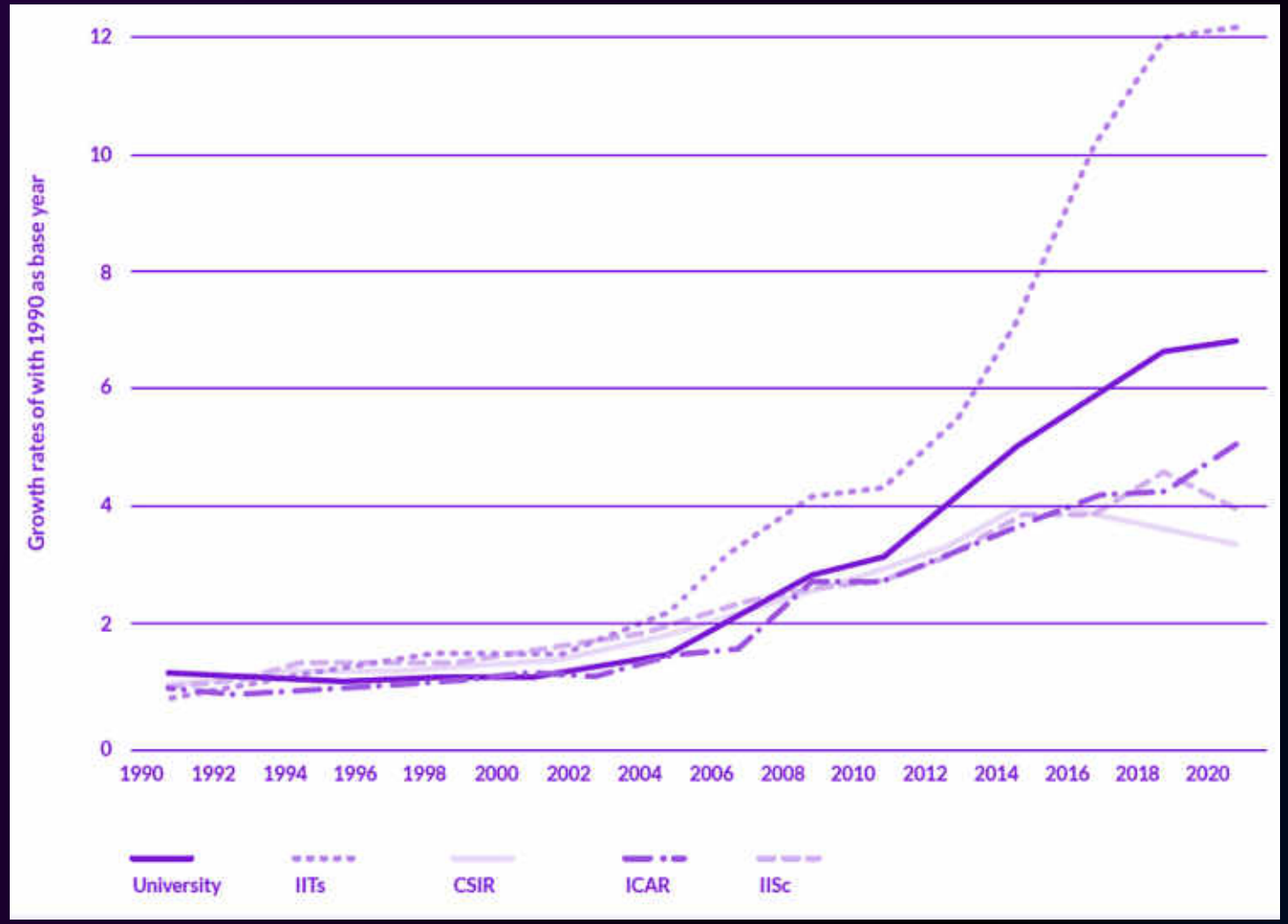
Country	R&D investment as a % of GDP	Contribution by industry (%)
South Korea	4.1	78
Japan	3.4	78
Austria	3.1	72
Germany	2.9	68
United States	2.7	72
United Kingdom	1.7	54
China	2.2	77
India	0.7	39

Private and philanthropy investments in R&D in India can go up considerably

Changing global ranking of India in SCI publications



IITs and universities are improving their research outputs



Global ranking of countries on various parameters

Country	Per capita income	Human Development	Knowledge Generation	Innovation	Economic sophisticatio n
United States	13	17	2	3	11
Germany	19	6	11	9	3
United Kingdom	26	13	9	4	12
Japan	28	19	12	16	1
Malaysia	47	62	33	33	24
Russia	57	52	45	47	52
China	79	85	31	14	16
Brazil	82	84	68	62	53
Vietnam	126	117	66	42	56
India	122	131	75	48	43

India does well on Global Knowledge Index and the Global Innovation Index, relative to its performance in overall Human Development Index.

Key future goals for S&T in India

S&T goals for India

Desired business and technology objectives for India

GDP of USD 9 - 10 trillion by 2030, and USD 40 trillion by 2047

By 2047, the digital economy being 30%-40% of India's economy

Achieve a Human Development Index of 0.9 by 2047

S&T goals for India

Desired business and technology objectives for India

3% of its GDP on R&D &

Top 10 in the global innovation index by 2030

In top 3 nations in the world in research and

technologies like AI, EV and green hydrogen

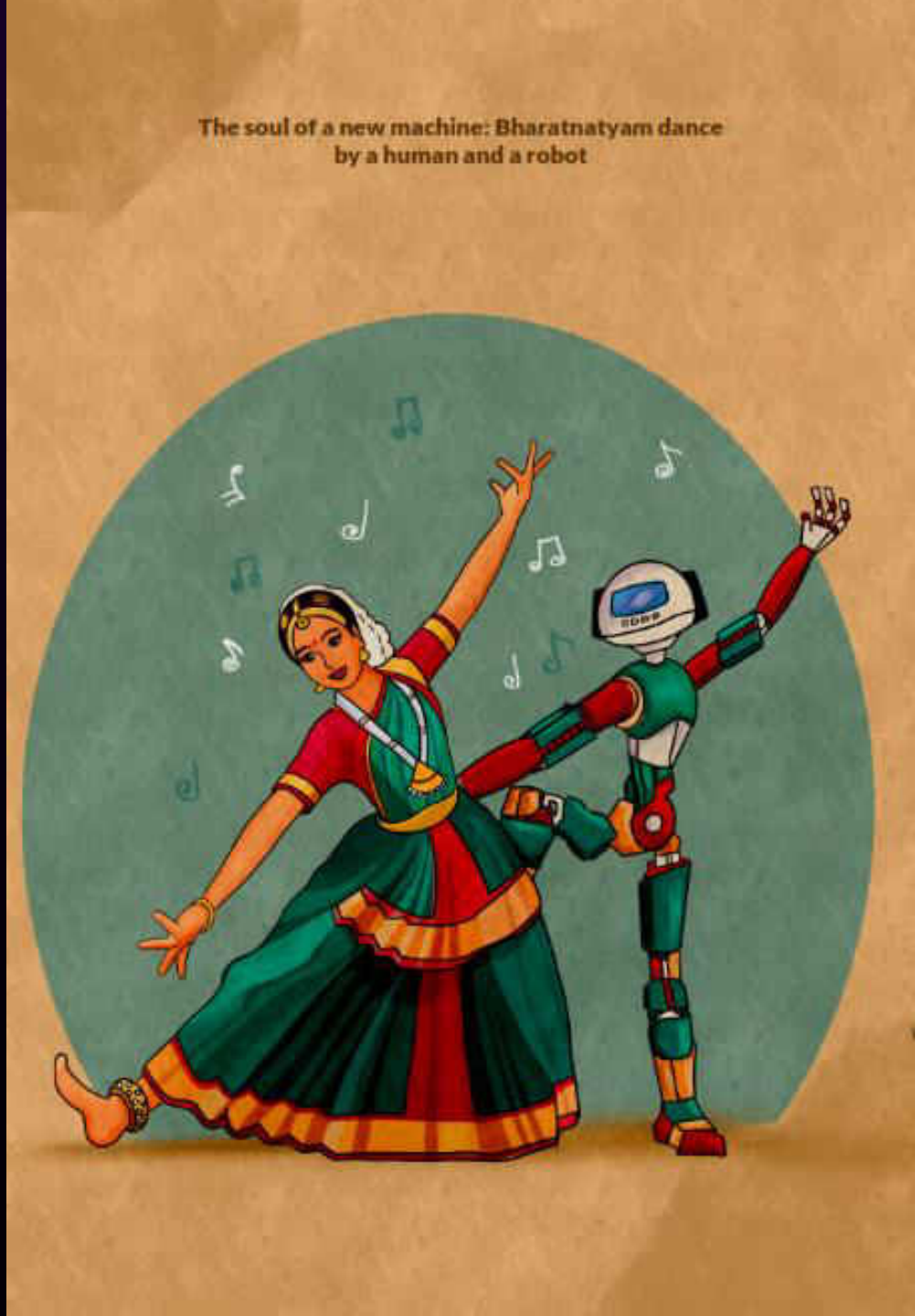
Gross Enrolment Ratio (GER) to reach 40% by 2030 and 50% by 2035

Recommendations

Information & Communication Technology (ICT)

- Recommendation #1: Embrace large-scale mission-mode programs in ICT.
- Recommendation #2: Develop world-class capabilities in AI.
- Recommendation #3: Focus on R&D for the full-stack of IT hardware.
- Recommendation #4: Actively participate in global technology standard setting.
- Recommendation #5: Harness and design technology for social good and digital inclusion.

Empowering India



#1: Embrace large-scale mission-mode programs in ICT

Mission-mode programs have clearly defined objectives, implementation milestones, as well as measurable outcomes.

National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)

- NM-ICPS has established Technology Innovation Hubs in 25 institutions
- In five years – goals include ~ 10,000 research fellowships, ~750 technologies (IPs and patents), and ~ 1100 startups and spin-off companies

National Quantum Mission

- Approved in 2023 at a total cost of INR 6000 crore
- The four domains of quantum technologies include computation, communication, sensing, and materials.

#2: Develop world-class capabilities in AI

1. Enhance quantity and quality of AI researchers

PhD Clinic

Anveshan Setu Fellowship Program

Uplink Research Internship Program

2. Create AI Centres of Excellence

Yardi School of Artificial Intelligence (ScAI)
Indian Institute of Technology, Delhi

RBCDSAI IITM

3. Develop niche capabilities in computational neuroscience

INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CENTER FOR COMPUTATIONAL BRAIN RESEARCH

Brain, Computation, and Data Science
IISc Bangalore

4. Develop capabilities to harness data for economic, social and public benefit

HUBDATA
IIIT HYDERABAD

IUDX
INDIA URBAN DATA EXCHANGE

Web Science at IIIT Bangalore

#3: Focus on R&D for the full-stack of IT hardware

1. Research and education focus on electronics system design & manufacturing (ESDM)

FlexE
National Centre for Flexible Electronics

IIT Kanpur

NCETIS

National Center of Excellence in Technology for Internal Security, IIT Bombay

2. Chip Design and Fabrication

SHAKTI

Open Source Processor Development Ecosystem

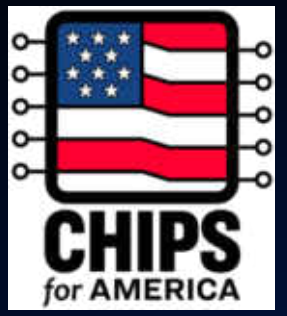
Initiative by the RISE group at IIT-Madras aims to build an ecosystem of production grade processors, SoC's and peripheral IP's.

3. Reference models - US

Microelectronics Commons

National Semiconductor Technology Center (NSTC)

National Advanced Packaging Manufacturing Program (NAPMP)



#4: Actively participate in global technology standard setting

Ministry of Electronics & Information Technology
Government of India

Creating a global technology standard

- 250+ engineers and 40+ faculty from IIT Madras, IIT Hyderabad, IIT Kanpur, IIT Bombay, IIT Delhi, IISc, SAMEER and CEWiT helped develop the 5G testbed
- Contributions from India towards rural a Low Mobility Large Cell (LMLC) scenario
- In 2020, TSDSI's Radio Interface Technology which was formally called "5Gi" was approved as an international telecom standard

#5: Harness and design technology for social good and digital inclusion

1. Educational Institutions and AI for social good

Researchers at IIIT Hyderabad has developed an ML model for risk and mortality prediction of COVID-19 patients

AIIMS Bhopal and IISc are able to detect COVID-19 biomarkers using Raman spectroscopy and AI

Runs an Indian-language translation AI initiative with an open-source community of engineers

IIT Bombay has developed AI models for better malaria diagnosis

IIT Kharagpur has developed an AI solution for automated reading of legal case judgements

2. Technology for digital inclusion / social good

IIIT Hyderabad

ACT4D Lab at IIT Delhi

TTK Center for Rehabilitation Research and Device Development at IIT Madras

IIIT Bangalore

National Language Translation Mission
Harnessing technology to transcend language barriers

Sustainability

Recommendation #6: Leverage advances in materials science research to address sustainability and water challenges.

Recommendation #7: Reimagine water management with digital technologies.

Recommendation #8: Promote inter-disciplinary collaboration and develop institutional mechanisms for water research and governance.

Recommendation #9: Create incubators and encourage entrepreneurship in the difficult areas of water and sanitation.

Recommendation #10: Address India's air quality and pollution challenges with urgency.

Recommendation #11: Strive for future energy security, keeping in mind the needs of urban and rural India.

Recommendation #12: Develop novel technology solutions for power generation and distribution.

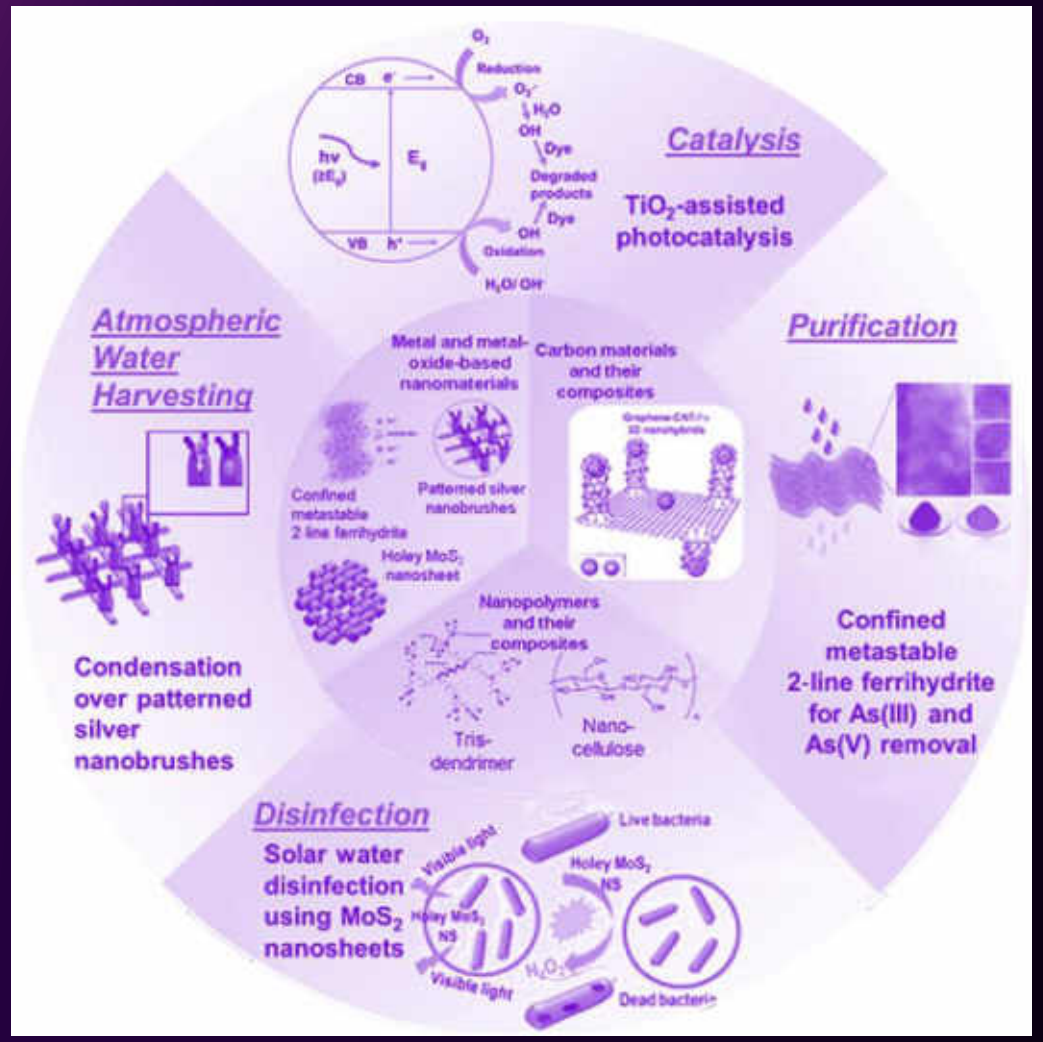
Recommendations #13: Conduct cutting-edge research and develop innovative solutions to reach net-zero carbon emissions in hard-to-abate sectors.

Recommendations #14: Pursue circularity in all sectors.

Recommendation #15: Nurture educational institutions that embrace collaborative research and prepare pragmatic future leaders in energy.

#6: Leverage advances in materials science research to address sustainability and water challenges

Materials Science is central to achieving SDG6.



Applications of nanomaterials in water

US EPA's Top 10 Water Market Opportunities

- Conserving and recovering energy
- Recovering nutrients
- Improving and greening of the water infrastructure
- Conserving and eventually reusing water
- Reducing costs and improving techniques for water monitoring
- Improving performance of small drinking water systems
- Reducing water impacts from energy production
- Improving resiliency of water infrastructure to the impacts of climate change
- Improving access to safe drinking water and sanitation
- Improving water quality of our oceans, estuaries, and watersheds

Reference Model: The US EPA's Top 10 Water Market Opportunities

#7: Reimagine water management with digital technologies

	Obtaining a complete, current and accesible picture of water supply and demand	Providing access to and quality of WASH services	Managing growing water demand	Ensuring water quality	Building resilience to climate change
3D Printing					
Advanced materials				●	
Advanced sensor platforms	●	●	●	●	●
Artificial Intelligence	●	●	●	●	●
Bio-technologies					
Blockchain		●	●	●	●
Drones and autonomous vehicles	●	●			
The Internet of Things (IoT)	●	●	●	●	●
Robotics					
Virtual, augmented and mixed realities					
New computing technologies	●	●	●	●	●

4IR Technology applications in water
(Source: World Economic Forum)

Create hydrologic digital twins

- For data-driven modelling of events such as flood inundation

Mitigating infectious diseases through surveillance of wastewater

#8: Promote inter-disciplinary collaboration and develop institutional mechanisms for water research and governance

An illustrative list of water centres in educational institutions of India

#9: Create incubators and encourage entrepreneurship in the challenging areas of water and sanitation

PUB SINGAPORE'S NATIONAL WATER AGENCY

By 2018, 200 companies and 25 research institutions had been aided by their programme.

These efforts in turn created 14,400 jobs

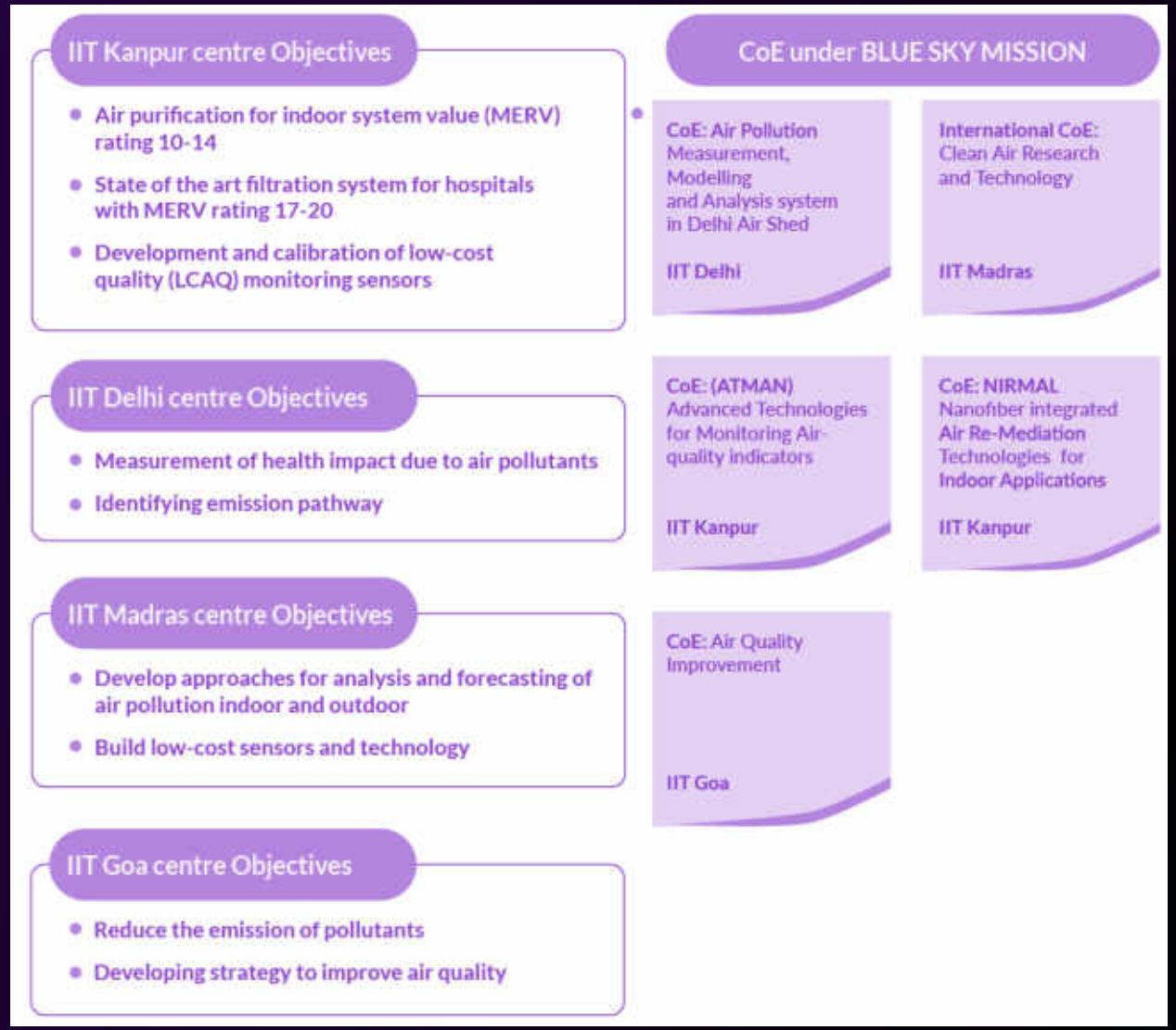
Added over SGD 2.5 billion annually to Singapore's GDP and enhanced the country's water resilience

The Thematic Unit of Excellence - Nanotechnology and ICCW at IIT Madras have incubated seven startups in water domain

CoE on global sanitation at IIT Palakkad established by the Office of Principal Scientific Adviser, GoI with an objective to incubate 50 startups

College students, early-stage entrepreneurs, innovators and researchers are mentored, provided entrepreneurship training, and then enabled to go for successful incubation.

#10: Address India's air quality and pollution challenges with urgency



Blue Sky Mission of Office of PSA

A number of CoEs focusing on air quality have been set up across the leading Indian educational institutions.

#11: Strive for future energy security, keeping in mind the needs of urban and rural India

977 kWh – annual per capita electricity generation in India in 2020

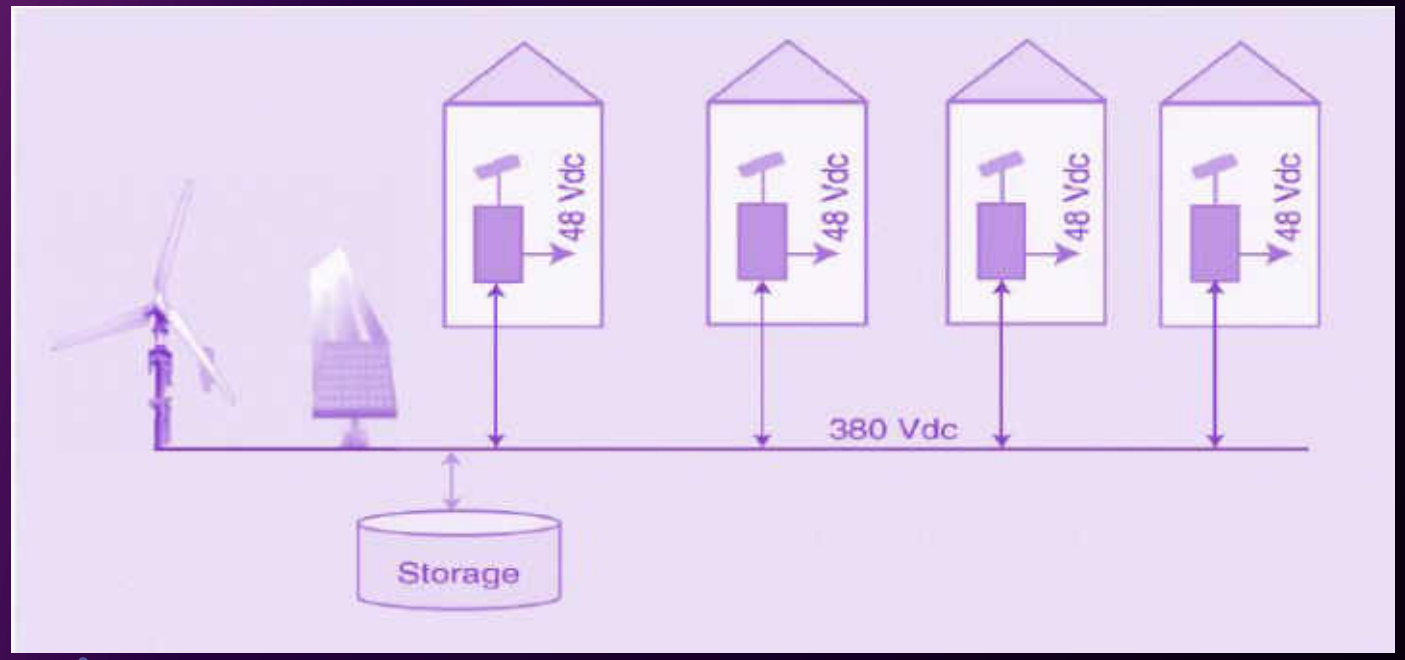
Comparison - 2570 kWh (Brazil) and 3777 kWh (South Africa)

2050

India should aim in 2050 for a per capita generation ranging from 3050 kWh to 5000 kWh

Energy security should be centred around availability, accessibility and affordability

#12: Develop novel technology solutions for power generation and distribution



Solar DC systems and microgrid solutions
A microgrid with centralized power generation sources and centralized storage

International Thermonuclear Experimental reactor
ITER is with the participation of EU, US, Russia, China, India, Japan, and South Korea

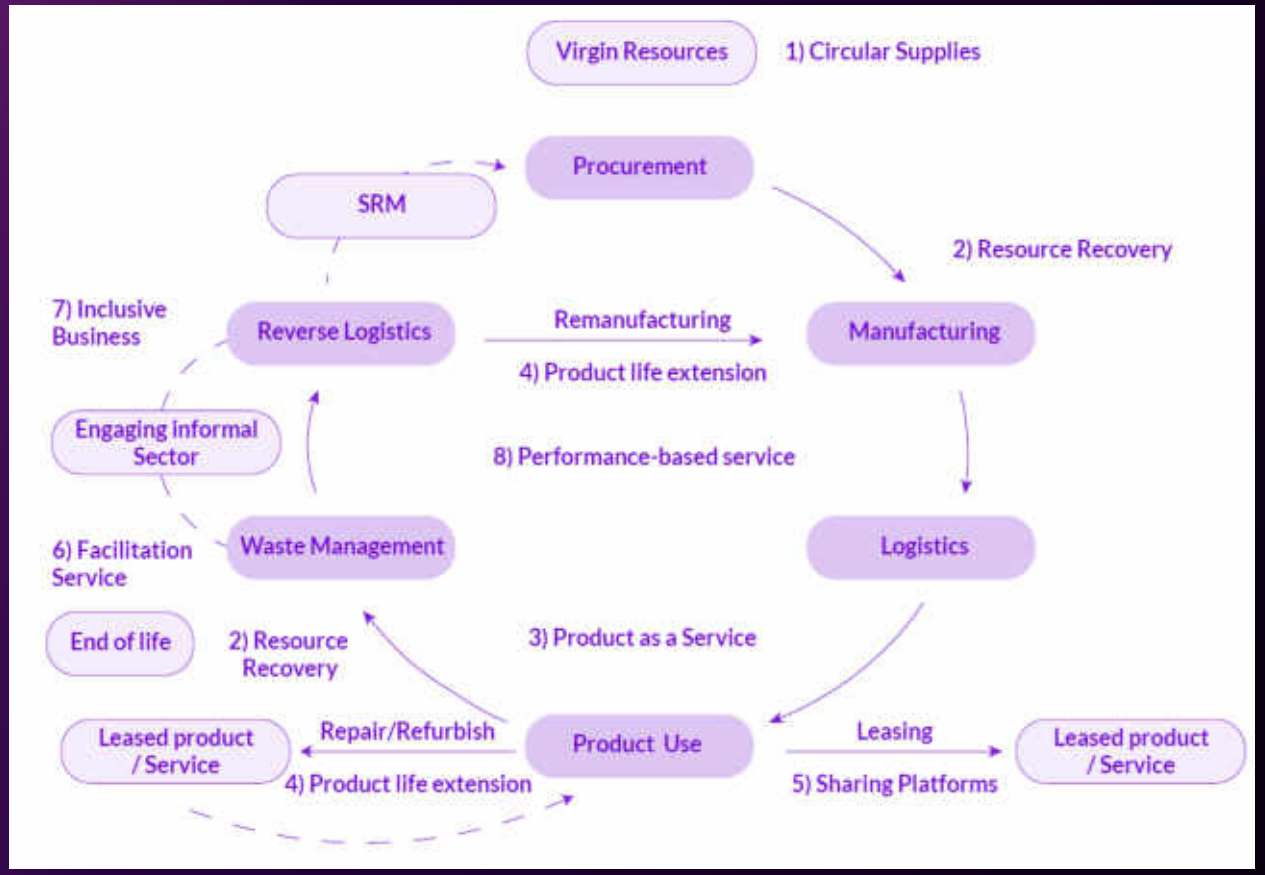
Green Hydrogen
Bring down the cost to USD 2.5/kg by 2025 and USD 1/kg by 2030

#13: Conduct cutting-edge research and develop innovative solutions to reach net-zero carbon emissions in hard-to-abate sectors

Timeline: 0-5 Years	5-10 years	10-15 years
Solar, Wind and wheeling of RE	Long term Storage: Zn-Air, Al-air	Small modular nuclear reactors
Grid storage: Chilled water + Battery	Ocean, Wave and Tidal energy	Compressed air storage
Energy efficiency in AC & Heat Pumps	Larger EVs and freight transportation	
Strengthening T&D grid for renewables	Green Hydrogen	
Hydro-electric storage	Usage of Green H2 in Cement production ++	
Electric Vehicles: 2W /3W	Usage of Green H2 in Steel production	
Energy Management System	Carbon Capture, Utilization and Sequestration	
Next Generation Solar (*Perovskites PV Cells*), Wind Turbines (Larger Capacity)		
Electrification of construction equipment		
Electrification of agriculture equipment		

List of technologies needed for net zero in India

#14: Pursue circularity in every domain and all sectors



Circular business models across life cycle of a product

Technologies for Low-Carbon Lean Construction

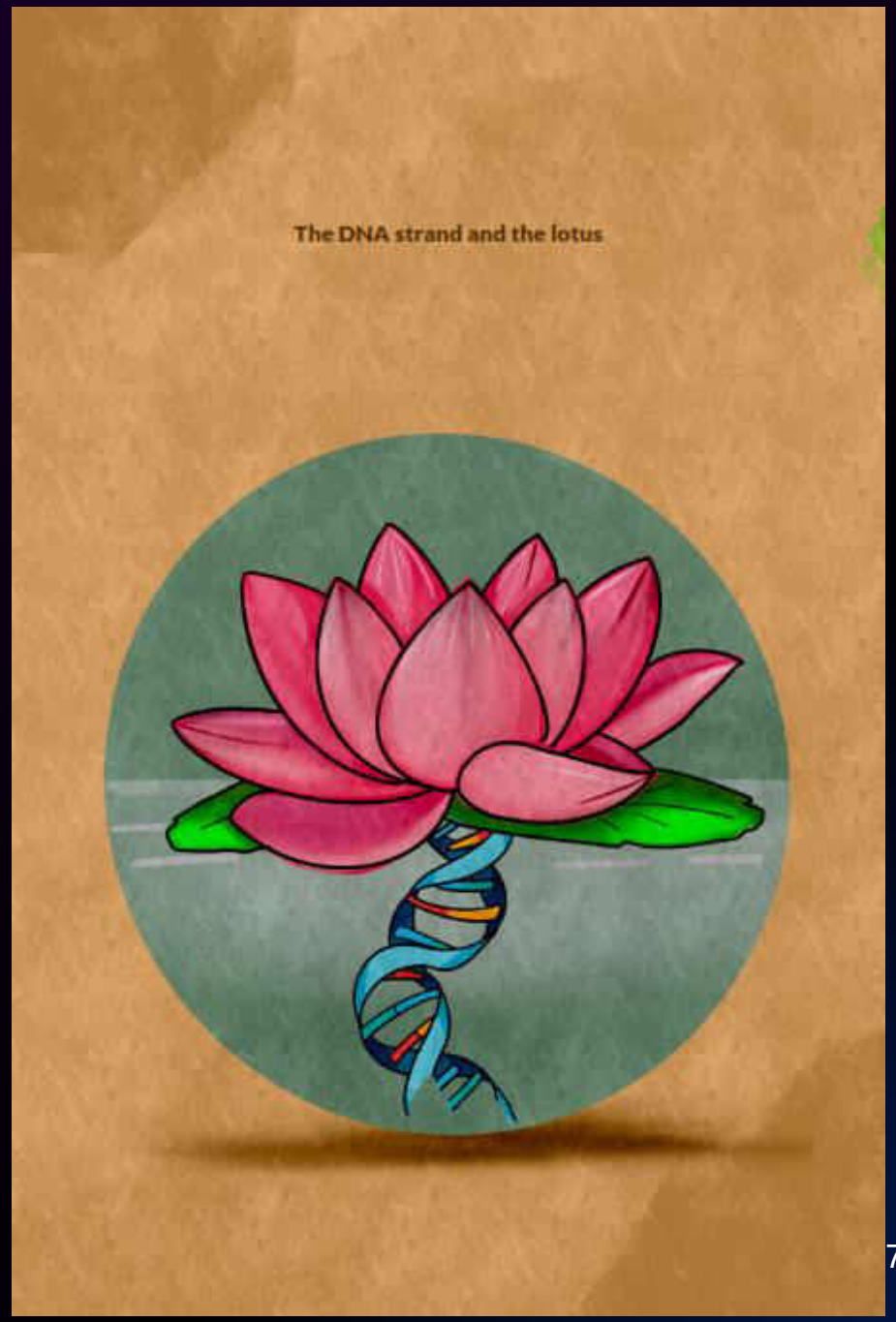
The TLC2 project at IIT Madras aims to develop innovative low-carbon lean construction technologies for minimizing waste throughout the construction value-chain, and lead solution implementation across organizational and policy levels.

#15: Nurture educational institutions that embrace collaborative research and prepare pragmatic future leaders in energy

Aspects of Sustainability for HEIs	
	Built on the foundational pillars of access, equity, quality, affordability and accountability, NEP 2020 is aligned to the 2030 Agenda for Sustainable Development.
	The higher education institutions should embrace the principles of sustainability, the UN SDGs, and bring about changes to their processes / methods for i) research, II) education, and iii) service, institutional models and societal interface.
	Foster **research** projects around sustainability. Move towards inter- and transdisciplinary modes of research, producing and circulating knowledge, foster dialogue and integrate diverse knowledge systems.
	Foster **educational** programs and centres that deal with theory and practices of sustainability, such as the degradation of nature, climate change, water conservation, sustainable and regenerative agriculture etc.
	Develop **service and institutional models** around sustainable development. Strengthen outreach and engagement with local communities on sustainability. Establish SDG-aligned and ‘sustainable campus’ policies that develop prototypes of sustainable institutions.

Biosciences and Biotechnology

- Recommendation #16: Embrace large-scale mission-mode programs and build capacities in bioscience and biotechnology.
- Recommendation #17: Develop affordable medical products and technologies by leveraging biosciences, biotechnology and other engineering disciplines.
- Recommendation #18: Develop strong national capabilities in genomics and genetic technologies.
- Recommendation #19: Embrace interdisciplinary biosciences education and build capacities through a skilled bio/healthcare workforce.
- Recommendation #20: Scale the biosciences innovation ecosystem and nurture biotech startups.



#16: Embrace large-scale mission-mode programmes and build capacities in bioscience and biotechnology

Atal Jai Anusandhan Biotech (UNaTI) Missions

- Addresses challenges of maternal and child health, AMR, vaccines for infectious disease, food and nutrition, and clean technologies

16 theme-based DBT institutions

- Pursue basic, discovery and translational research in the areas of agriculture biotechnology, animal biotechnology, medical biotechnology, clean energy and bioresources development, secondary agriculture, etc.

CENTRE FOR BRAIN RESEARCH
CBR

Sudha Gopalakrishnan
BRAIN CENTRE

Focus on brain sciences

CBR: To understand age-related brain disorders, and to model how the brain works.

Brain Centre: To map human brains at cellular level.

#17: Develop affordable medical products and technologies by leveraging biosciences, biotechnology and other engineering disciplines

A portable Raman spectrometer has been developed at Amrita Centre for Nanosciences and Molecular Medicine Kochi for cancer diagnosis

Sree Chitra Tirunal Institute for Medical Sciences & Technology and IIT Delhi have developed scaffolds for endodontic tissue regeneration

Nanobiotechnology

- IISER Bhopal has designed a probe for detection of serum albumin
- IIT Hyderabad has prepared a dissolved oxygen sensor

IISc plans to set up a postgraduate medical school along with a multi-speciality 800-bed hospital

To offer an integrated dual degree MD-PhD programme aimed at creating a new breed of physician-scientists

IIT Kanpur plans to set up the Gangwal School of Medical Sciences and Technology, which will include a 500-bed Super-Specialty Hospital and Centres of Excellence for pursuing R&D activities in futuristic medicine

#18: Develop strong national capabilities in genomics and genetic technologies

Recommendations : CII National Task Force on Science and Data (Genomics)	A National Level Consortium comprising Next-Gen Sequencing facilities, Cryo-EM facilities, Gene and Plasmid Synthesis facility, cell culture facility of laboratory level trials, and computational facilities can be formed
	Assist the national institutes specialized in research on pandemic diseases (like National Institute of Virology), cell and gene therapy, immunology (like National Institute of Immunology) to develop expertise in Omics (genomics, proteomics, metabolomics, metagenomics and transcriptomics) and data mining
	Form a centrally funded institute focused on research on genomics, gene delivery platforms such as recombinant viral vectors, cellular therapy, synthetic biology (mRNA synthesis and production), gene delivery formulations
	Focus on development of new genomic related technologies/analytical/computational methods including supercomputing, data science, electrophoresis, northern blot, bioinformatics, gene synthesis, chip sequencing, etc.

#19: Embrace interdisciplinary biosciences education and build capacities through a skilled bio/healthcare workforce

The biology or the life sciences department at the IISER is one division and not subdivided into botany, zoology, etc.

Importance is given to theoretical and field biology. The IISER faculty give equal emphasis on teaching and research

Students are provided training on research methodology, scientific communication, bioethics, etc.

Reference Model: The Oxford Martin Program on Pandemic Genomics

Brings together mathematical epidemiology, pathogen phylodynamics, and human geography. The program will develop and validate a prototype that will be tested on data from past and future outbreaks of emerging
infectious disease.

#20: Scale the biosciences innovation ecosystem and nurture biotech startups

C-CAMP
Centre for Cellular and Molecular Platforms

C-CAMP facilitates bioscience research and entrepreneurship by providing research, development, training and services in state-of-the-art technology platforms.

It has supported over 250 institutions in India, and has directly funded, incubated and mentored over 100 startups over the last few years.

Under the C-CAMP COVID-19 Innovations Deployment Accelerator (C-CIDA) programme, 22 innovations went into deployment and touched 1 million+ lives in the COVID-19 fight.

SCHOOL OF INTERNATIONAL BIODESIGN

CENTRE FOR BIOSYSTEMS SCIENCE & ENGINEERING
INDIAN INSTITUTE OF SCIENCE, BANGALORE

Healthcare Technology Innovation Centre
Collaborate · Innovate · Impact

thsti
TRANSLATIONAL HEALTH SCIENCE AND TECHNOLOGY INSTITUTE

Biodesign Centres: DBT has established four biodesign centres to promote medical technology innovation in India. These centres bring together medical and engineering schools, and help create affordable and India-context specific medical solutions.

iPEPS
The Healthtech Hub
Institut du Cerveau

Reference model: France's first innovation accelerator dedicated to brain diseases.

Research and Technology Development

Recommendation #21: Synthesize a national system of innovation for emerging technologies.

Recommendation #22: Adopt innovative models and mechanisms for supporting research, application and outreach in every institution.

The peacock scientist in a rain of experiments
(Source: Adapted from an image by DALL.E, OpenAI)

#21: Synthesize a national system of innovation for emerging technologies

National Research Foundation

New Education Policy
Educate Encourage Enlighten
नई शिक्षा नीति करे सशक्त, ज्ञान, योग्यता और रोज़गार।

Organizational strategy, structure, processes and culture focussed on building a research capability in emerging technologies

Foster collaboration with other organizations in the national system of innovation

Earth observation satellite programs – technology development at Indian Space Research Organization (ISRO)

Reference Model – NSF, US
Use-inspired research, solutions-focused innovations through the Technology, Innovation and Partnership (TIP) Directorate

National innovation framework
ASSURED comprises seven important attributes, namely, being affordable, scalable, sustainable, universal, rapid, excellent, and distinctive.

#22: Adopt innovative models for augmenting quality and funding of institutional level research

Priority focus areas among stakeholders

- Outstanding Individual Researchers
- Research / Educational Institutions
- Research Community (students, researchers, faculty)

Priority focus areas in scope of work

- Prizes, Challenges, and Grants
- Knowledge Dissemination
- STI Infrastructure Set-up
- STI Capability & Policy Development

Models for furthering institution-level research (Source: itihaasa Research and Digital)

Enhancing Researcher Quality

Overseas Research Fellowship

University Research Parks

Universities as Living Labs

Innovation and Entrepreneurship

Recommendation #23: Nurture an innovation and entrepreneurship ecosystem focused on deep-tech.

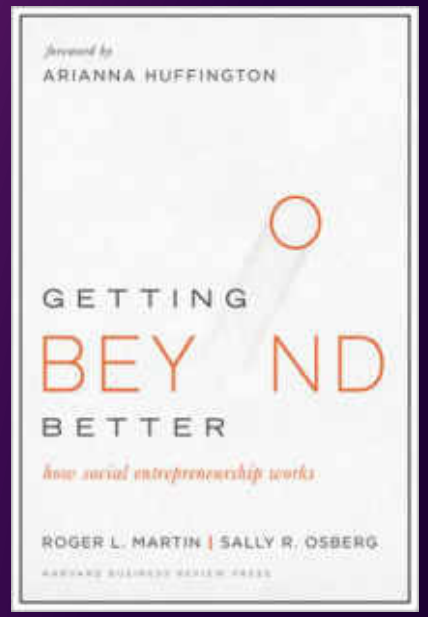
Recommendation #24: Create societal platforms and infrastructure to nurture social entrepreneurship.

#23: Nurture entrepreneurship ecosystem focused on deep-tech

Reference Model: The IIT Madras Innovation and Startup Ecosystem

- 1. The Entrepreneurship Cell of IIT Madras (E-Cell) is a student hub for entrepreneurship-related activities at IITM.
- 2. The Centre for Innovation (CFI) housed within the Central Workshop complex provides a maker space/student-tinkering lab.
- 3. Nirmaan: A pre-incubation cell which serves as the student startup lab
- 4. The IITM Research Park and the Incubation Cell, which become a natural home for many of the startups from campus and beyond.
- 5. Sector-specific incubators of IIT Madras like Rural Technology Business Incubator, Bio-incubator, Healthcare Technology Innovation Centre and Pravartak Foundation.
- 6. Alumni groups like the IIT Madras Entrepreneurs Forum
- 7. Programs to support entrepreneurship among faculty and research scholars such as the Gopalakrishnan Deshpande Centre for Innovation & Entrepreneurship

#24: Create societal platforms and infrastructure to nurture social entrepreneurship



Social entrepreneurs who achieve meaningful scale of impact do the following

- they design explicitly for scale economies
- they take a systemic approach, leveraging other actors in an ecosystem rather than attempting to work alone
- they choose to be open-source in their approach and encourage others to build on their models
- they document their model and refine it over time

RTBi
IITM's Rural Technology and Business Incubator

CIIE.CO
BUILT AT IIMA

IIMB
तेजस्वि नावधीतमस्तु

NSRCEL

TSIC
ఇంటింటా ఇన్నోవేటర్

राष्ट्रीय नवप्रवर्तन प्रतिष्ठान – भारत
विज्ञान एवं प्रौद्योगिकी विभाग, भारत सरकार का स्वायत्तशासी संस्थान
National Innovation Foundation - India
Autonomous Body of the Department of Science and Technology, Govt. of India

Academia – Industry Relations and Alumni Engagement

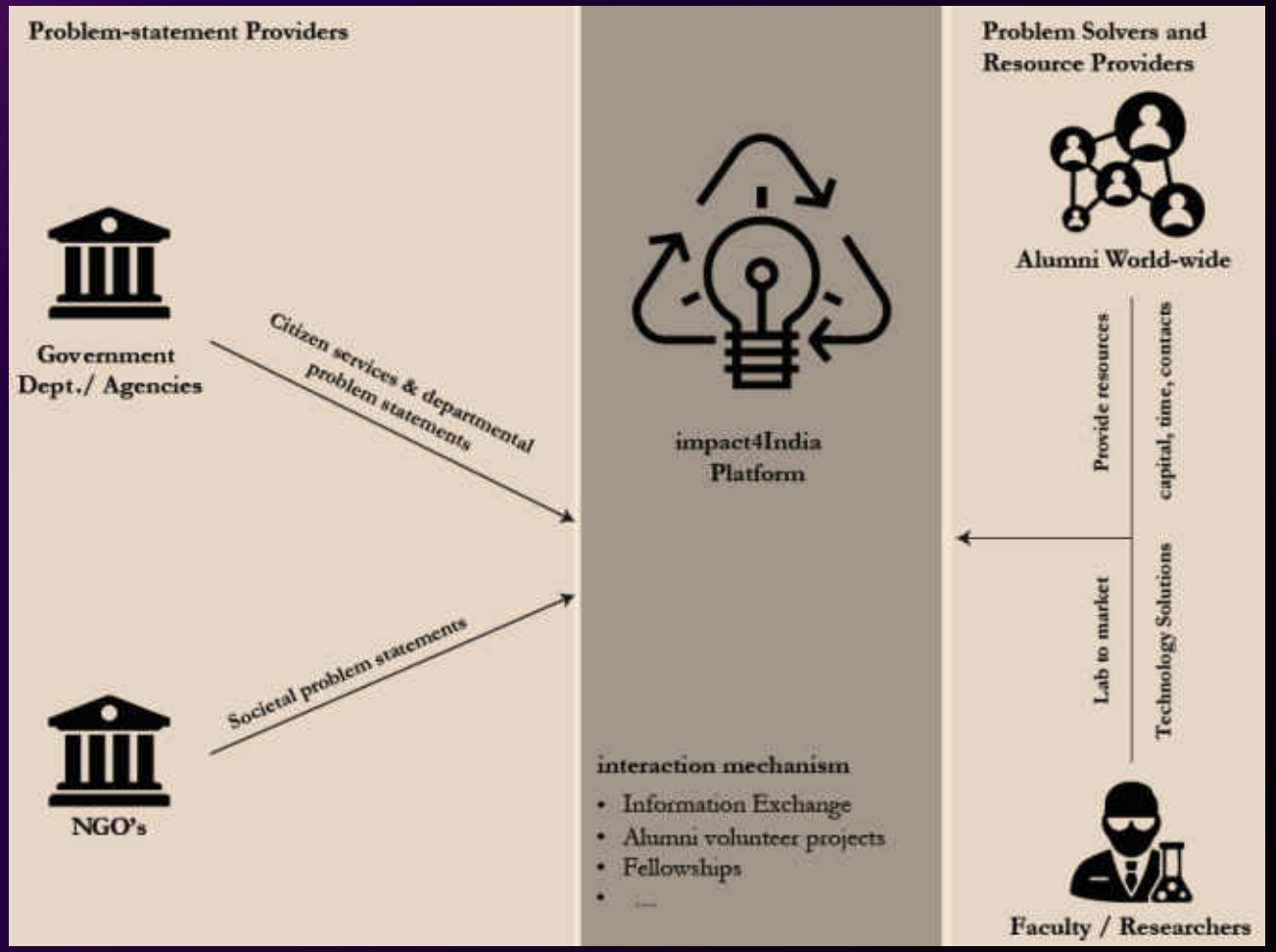
Recommendation #25: Address the top ten gaps in Industry – Academia relations.

Recommendation #26: Systematically tap into the alumni network for their 3Ts - time, talent and treasure.

#25: Address the top ten gaps in industry – academia relations

1. Engagement and Awareness	2. Learning and Skills	3. Idea to Execution	4. Broader Areas
• Communication regarding needs and capabilities • Exposure of academics to the industrial environment, and vice versa	• Industry-relevant curriculum • Perception of role of industry internships in the academic curriculum • Industry-ready graduates — whose responsibility?	• Appetite for risk-taking in academia versus industry • IP ownership • Nurturing startups from an academic campus — industry role	• Role of industrial consortia in enhancing academic research • Socially-relevant research, vis-à-vis application-specific

#26: Systematically tap into the alumni network for their 3Ts - time, talent, and treasure



IIT Madras Alumni Association

IIT MADRAS FOUNDATION

PALS

ALUMNI CENTRE

BOMBAY ALU ASSOCIATION

Human Enablement - Education and Skill Development

Recommendation #27: Embrace innovations in online education - NPTEL, SWAYAM and others.

Recommendation #28: Implement the vision of NEP by experimenting with other innovative education models.

Recommendation #29: Reskill talent for the needs of the digital world and the jobs in the future.

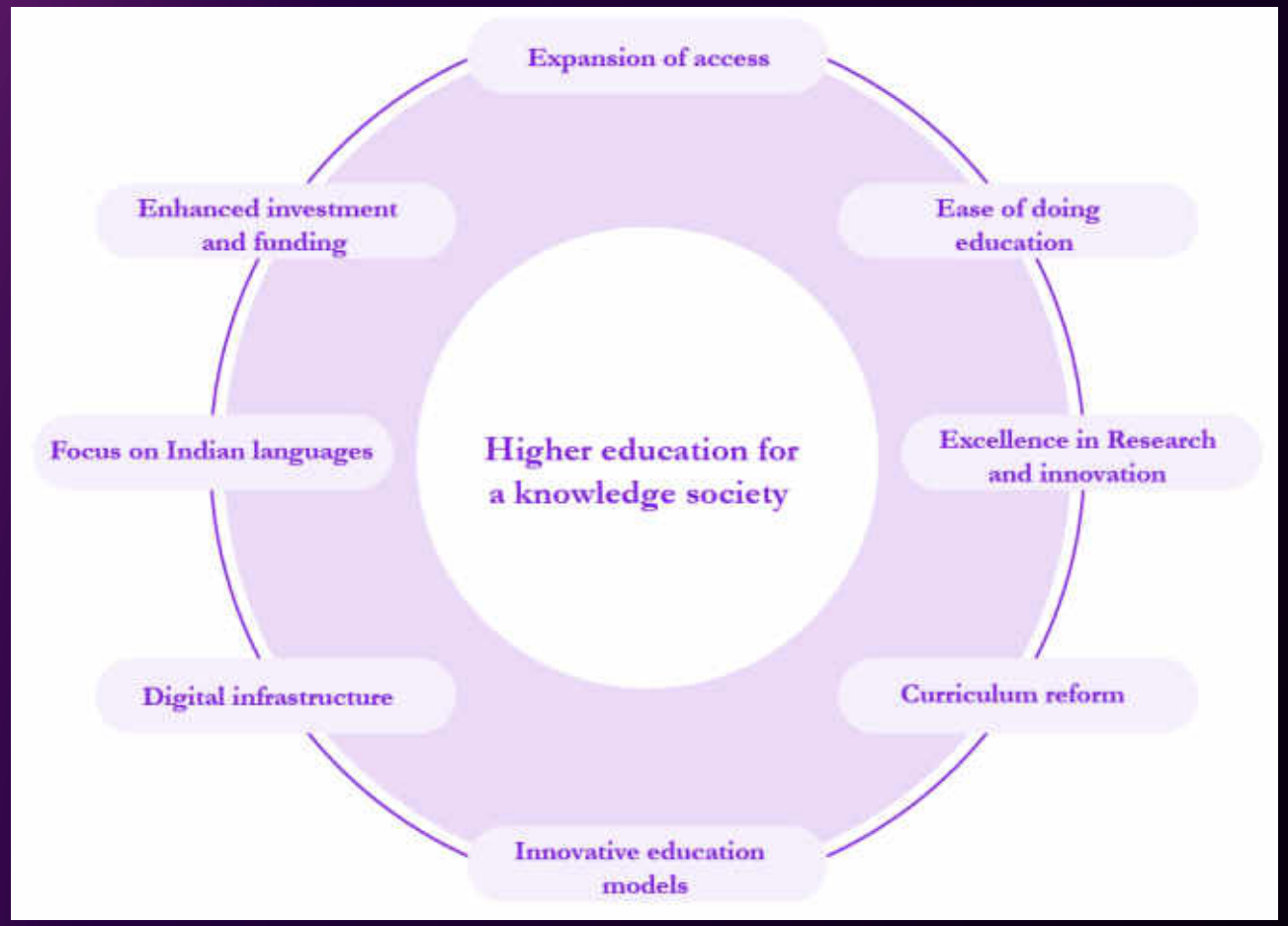
Recommendation #30: Skill talent for the needs of India.

#27: Embrace innovations in online education - NPTEL, SWAYAM and others

NPTEL has been hugely successful, in terms of its reach and impact.

- It is the largest online repository in the world of courses in engineering, basic sciences and selected humanities and social sciences subjects.
- NPTEL has seen 1.6 crore+ enrolments, 15 lakhs+ exam registrations, 4500+ local chapter colleges, 3500+ MOOCs completed, 60+ Industry associates, 2300+ unique courses available for self-study.
- The YouTube channel for NPTEL is the most subscribed educational channel, with 1.3 billion views and 37+ lakhs subscribers.
- Many colleges across the country, be it engineering or science, have very poor facilities in terms of laboratories for performing experiments, especially colleges in Tier 2 and Tier 3 towns.

#28: Implement the vision of NEP by experimenting with other innovative education models



筑波大学
University of Tsukuba

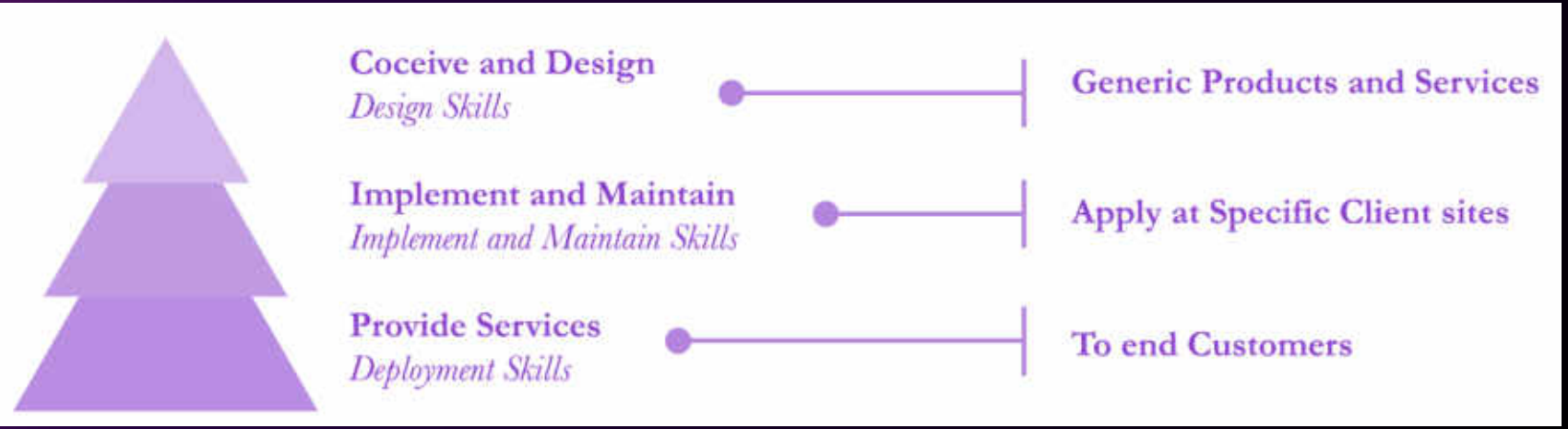
Tsukuba Science City contains the 'Research and Education District'

Innovative education models at IIT Gandhinagar and IIT Hyderabad

Game-based learning

Systems thinking

#29: Reskill talent for the needs of the digital world and jobs in the future



Skill-sets trifurcation model

europass
European Union

The European Vocational Qualifications Framework (EQF)

#30: Skill talent for the needs of India

Deshpande Foundation

- Nurture social and micro-entrepreneurship in the hinterlands of India.
- Innovation sandbox of a 'living laboratory' for local social entrepreneurs
- Elevate skilling and Navodyami program

Encourage women social/micro-entrepreneurship especially in the light of the falling Female Labour Force Participation (FLPR) rates in India

Create an Udyog Sahayak Enterprises Network (USENET) for large- scale employment generation and scale-up in the MSME sector

Epilogue

itihaasa
Research and Digital

Scientists used AI to build a low-lithium battery from a new material that took just hours to discover

News By Victoria Atkinson published January 19, 2024

Microsoft's AI tool narrowed 32 million theoretical materials down to 18 in just 80 hours — with scientists synthesizing one that can reduce Lithium usage in batteries by 70%.

https://www.livescience.com/technology/artificial-intelligence/scientists-built-a-low-lithium-battery-from-a-new-material-that-took-just-hours-to-discover-thanks-to-ai

JANUARY 30, 2024 | 6 MIN READ

Elon Musk's Neuralink Has Implanted Its First Chip in a Human Brain. What's Next?

The wealthiest person on Earth has taken the next step toward a commercial brain interface

https://www.scientificamerican.com/article/elon-musks-neuralink-has-implanted-its-first-chip-in-a-human-brain-whats-next/

NEWS | 07 July 2023 | Correction 11 July 2023

Scientists used ChatGPT to generate an entire paper from scratch – but is it any good?

By designing an autonomous system that fed prompts to the chatbot, researchers produced a paper that was fluent and insightful. Yet they still have concerns.

https://www.nature.com/articles/d41586-023-02218-z

Call for Action

We plan to conduct an event at IIT Madras – a hands on workshop – on "**An execution plan for augmenting research quality and quantity**" based on the recommendations of the Empowering India book.

Request you and your leadership teams to participate in this event.

Tentative timeline: 1st week of December 2024

A lecture like this one may be arranged in your institution for the leadership of your institution.

Thank you

Thalappil Pradeep and

Krishnan Narayanan

EMPOWERING INDIA

Ideas for Action
by Scientists and Engineers

Thalappil Pradeep and Krishnan Narayanan

"This book highlights directions for action to make India successful by harnessing the power of science and technology… The book has come at the right time when India is looking forward to excellence in every sphere of activity."
C.N.R. RAO

"I am immensely happy to see this thoughtful and thoroughly researched book, happening at the right time. The book articulates a number of innovative models and recommendations for 21st century education and they can help in translating the principles of National Education Policy 2020 into action."
K. KASTURIRANGAN

"The authors have done an important service by writing this book. They have provided detailed recommendations and several useful reference models for promoting science, technology and innovation in the country… I encourage you to read this book and get inspired to act in your communities."
GURURAJ "DESH" DESHPANDE

"This book is timely, comprehensive, and interesting... I also endorse their ideas for the development of medical technologies indigenously as the import dependence and consequent high cost have made them inaccessible to the majority of our needy population. I wholeheartedly recommend this book to policymakers, leaders of scientific institutions and industry in the country."
M.S. VALIATHAN

"This book with the most appropriate recommendations has come at the right time when the nation is poised to contribute to the world in the area of science and technology in the next 25 years. I am sure that the publication of this book is in the right direction."
SOMANATH S

"The book explores ways in which we must nurture the research and innovation ecosystem in India, and to make it an engine that powers our aspiration of becoming a developed economy."
S. 'KRIS' GOPALAKRISHNAN

Anand Raghunathan
Professor, Purdue University

Arindam Ghosh
Professor, Indian Institute of Science

B. N. Suresh
Chancellor, Indian Institute of Space Science and Technology, Trivandrum

B. Santhanam
CEO, Saint-Gobain Asia Pacific & India

Govidasamy Mugesh
Professor, Indian Institute of Science

Kris Gopalakrishnan
Co-founder, Infosys

Ramgopal Rao
Group Vice-Chancellor for BITS Pilani and former Director, IIT Delhi

S. Sadagopan
Former Director, IIIT Bangalore

Sangamitra Bandopadyhya
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&

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itihaasa Research and Digital is a not-for-profit, Section 8 company that aims to understand the evolution of technologies and innovation in India.

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