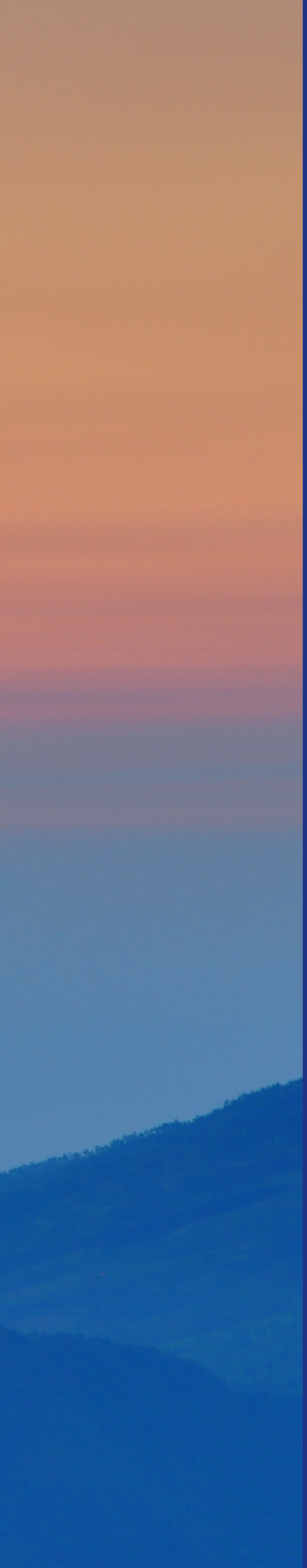

NOVEMBER 2020

Action Agenda for *Atma Nirbharta (AAAN)*

TECHNOLOGY INFORMATION, FORECASTING & ASSESSMENT COUNCIL (TIFAC), DST

Action Agenda for Atma Nirbharta (AAAN)

(A follow up to TIFAC White Paper on 'Focussed interventions for Make in India post COVID-19' released in July 2020)

Technology Information, Forecasting & Assessment Council,DST

November, 2020

DISCLAIMER

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Any specific follow up action by any industry etc. to be done only after professional advice and assessment of the situation.

TIFAC

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सबका साथ, सबका विकास, सबका विश्वास
Sabka Saath, Sabka Vikas, Sabka Vishwas

सत्यमेव जयते

डॉ हर्ष वर्धन
Dr Harsh Vardhan
स्वास्थ्य एवं परिवार कल्याण, विज्ञान और प्रौद्योगिकी व पृथ्वी विज्ञान मंत्री, भारत सरकार
Union Minister for Health & Family Welfare, Science & Technology and Earth Sciences Government of India

MESSAGE

TIFAC has done a very commendable job earlier in bringing out a White Paper on "Focussed Interventions for 'Make in India' –*post* COVID 19". The Paper showed the way for using COVID-19 pandemic as an opportunity to propel India through a big push for "Make In India" towards the path of prosperity.

Now as a follow up to the White paper, TIFAC has defined a detailed road map very aptly titled Action Agenda for Atma Nirbharta or "AAAN" to achieve the objective of making our country "Atma Nirbhar" and also achieve the target of 5 trillion-dollar economy.

I am told that TIFAC has, in the process, organized national level brainstorming workshops involving top experts and policy makers in preparing the road map.

I am sure "AAAN" will be very useful in protecting and promoting the AAAN of our country.

I wish TIFAC all the best in this endeavour !

(Dr. Harsh Vardhan)

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सत्यमेव जयते

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Prof. Ashutosh Sharma

स्वच्छ भारत
एक कदम स्वच्छता की ओर

DST@ 1971-2021 DEPARTMENT OF SCIENCE & TECHNOLOGY

सचिव
भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
विज्ञान एवं प्रौद्योगिकी विभाग
Secretary
Government of India
Ministry of Science and Technology
Department of Science and Technology

MESSAGE

The COVID-19 pandemic with the passage of time has drawn a *new normal* of leading lives and has taught us the need to build a robust ecosystem in terms of innovation and technology development leading to new business models towards revival of nation's economy.

Technology Information, Forecasting & Assessment Council (TIFAC), being a think tank under the Department of Science and Technology, brought out a White Paper titled 'Focussed interventions for Make in India, post COVID 19'. As a follow up, TIFAC has prepared another action oriented document : Action Agenda for Atma Nirbharta (AAAN) with focussed sectoral interventions required by different stakeholders.

AAAN has been prepared as a recommendation from the series of post-release brainstorming workshops for the White Paper. The workshops were enriched by eminent experts and policy makers who have contributed in charting out detailed and specific recommendations along with steps to achieve the goals envisaged in the White paper.

I am confident that this document would be very useful in shaping the Indian economy in days ahead and change the pace of transformation.

(Ashutosh Sharma)

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FOREWORD

TIFAC had brought out the **White Paper on Focused Interventions for 'Make in India': post COVID -19** in July, 2020, which has highlighted five thrust sectors namely, Healthcare, Machinery, ICT, Agriculture, Manufacturing, and Electronics that would be critical for India's economic growth using technology stimulus and captured sector-specific strengths, market trends and opportunities. The Paper had suggested new models for recovery of Indian economy with reference to strengthening supply-demand ecosystem.

Post-release of the white paper and in order to maximise the impact of the White paper on the economy recovery of the Nation, a detailed action oriented roadmap will be necessary. Towards this, TIFAC followed a consultative approach and organised a series of brainstorming workshops involving key players of each sector covering Industry, Academia, R&D Institutes and Policy makers. The detailed deliberations have been presented in a concise form, in this report aptly titled "AAAN" as an Action Agenda for an Atma Nirbhar Bharat. The action plan has been structured timeline-wise highlighting short/medium and long term interventions. Overarching policy recommendations in terms of Innovation and Technology development, Technology Adoption/Diffusion, Boosting up Manufacturing and Productivity, Trade and Globalization, Internet Policy and Data Management & Education and Training have also been covered.

I am sure this AAAN would be very useful for the policy makers, industries and other stakeholders and go a long way in making our Country "Atma Nirbhar"!.

(Dr. V K Saraswat)
Chairman, TIFAC Governing Council

New Delhi
27.10.2020

स्वच्छ भारत

TABLE OF CONTENTS

Executive Summary

Prof. Pradeep Srivastava
Executive Director, TIFAC

The ongoing pandemic, COVID-19 onslaught has torn the world apart. The World today is experiencing an unprecedented health and economic crisis. A widespread deep global recession has been bolstered, undermining global cooperation and multilateralism. The most outward global economies have turned inwards and are designing enhanced measures for rebooting and resilience of the economy.

The TIFAC's White Paper on Focused Interventions for 'Make in India': post COVID -19 which was released in July, 2020, has highlighted five thrust sectors namely, Healthcare, Machinery, ICT, Agriculture, Manufacturing, and Electronics that would be critical for India's economic growth using technology stimulus and captured sector-specific strengths, market trends and opportunities.

Post-release of the white paper, as a consequential follow-up, and in order to maximise the impact of the White paper on economic resilience, TIFAC followed a consultative approach and organised a series of brainstorming workshops involving key players of each sector covering Industry, Academia, R&D Institutes and Policy makers. The detailed deliberations and specific recommendation have been presented in this comprehensive report titled "AAAN" as an Action Agenda for an AtmaNirbhar Bharat.

This comprehensive action plan (AAAN) has been structured with reference to timeline, highlighting short/medium and long term interventions in various identified sectors. The document also specifically defines overarching policy recommendations with reference to technological inputs, focussing towards Local to Global thereby reviving Indian economy, in identified domains of Innovation and Technology development, Technology Adoption/Diffusion, Boosting up Manufacturing and Productivity, Trade and Globalization, Internet Policy and Data Management & Education and Training. The various specific sectors as identified and referred in AAAN document need diligent and strong financial and policy support.

I am aware that the Government of India has already taken a host of measures and policy decisions to make India an investor friendly destination but still a lot more is required to be done to meet the new challenges posed by the pandemic and to guide investors looking for safe investment destinations and domains, making India the global Manufacturing Hub. The

AAAN has also emphasized on the need for investing majorly in Innovation, Technology transfer and Translation.

(Prof. Pradeep Srivastava)

1.0 Introduction

India has traversed a path of liberalized democratic value with a formal open institutional economy post-independence. After the onset of globalisation in 1991, Indian economy had begun taking impressive strides. However, recently, COVID-19 pandemic has disrupted entire world very badly. The world today is experiencing an unprecedented health and economic crisis. Millions of people have succumbed. It has also sparked deep global recession, undermining global cooperation and multilateralism.

With the pandemic onslaught and nationwide lockdown, the economy has taken a very bad shape. There has been significant reduction in orders and cash flow across the sectors. Supply chains have been disrupted and businesses have experienced a significant downslide. The economic data reveals that economies of developed nations like US, Germany, UK, France etc are also very badly hit.

However, the recovery has been sharp too, especially in the months of July, August and September 2020 onwards. The following table gives a quick comparison of PMI data for several countries in the recent months and for India it is the highest since 2012.

TABLE 1: MANUFACTURING PMI DATA OF VARIOUS COUNTRIES

Countries	**Jan 20**	**Feb 20**	**Mar 20**	**Apr 20**	**May 20**	**Jun 20**	**Jul 20**	**Aug 20**	**Sep 20**
FRANCE	51.1	49.8	43.2	31.5	40.6	52.3	52.4	49.8	51.2
GERMANY	45.3	48.0	45.4	34.5	36.6	45.2	51.0	52.2	56.4
U.K.	50.0	51.7	47.8	32.6	40.7	50.1	53.3	55.2	54.1
BRAZIL	51.0	52.3	48.4	36.0	38.3	51.6	58.2	64.7	64.9
U.S.	51.9	50.7	48.5	36.1	39.8	49.8	50.9	53.1	53.2
CHINA	51.1	40.3	50.1	49.4	50.7	51.2	52.8	53.1	53.0
JAPAN	48.8	47.8	44.8	41.9	38.4	40.1	45.2	47.2	47.7
INDIA	**55.3**	**54.5**	**51.8**	**27.4**	**30.8**	**47.2**	**46.0**	**52.0**	**56.8**

Source: https://www.fxempire.com

The world today is very optimistic for the recovery and looking for a silver lining. In a survey conducted by McKinsey & Company, respondents of several countries had a very optimistic outlook about the economy POST COVID, in the next six months as shown below:

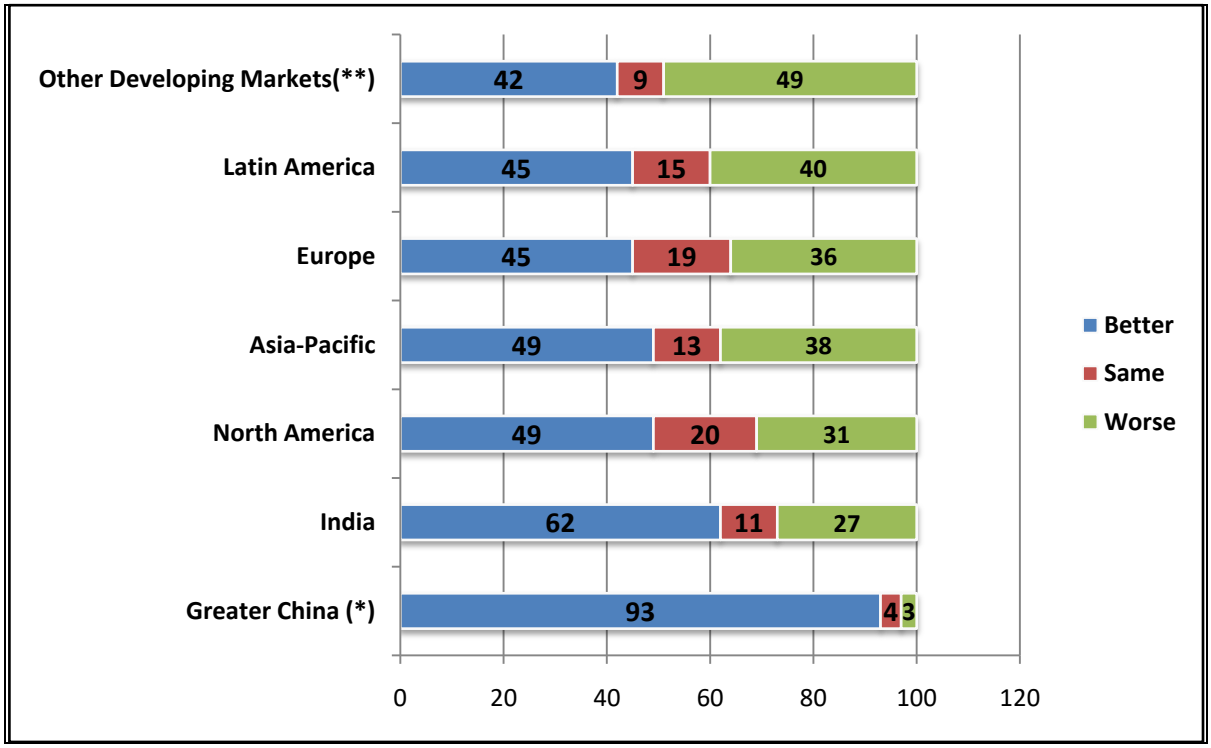


FIGURE 1: SURVEY OUTCOME ON STATUS OF POST-COVID ECONOMY

The figures reflect % of respondents by office location- Greater China, n=103; India, n = 74; North America, n=259; Asia-Pacific, n=136; Europe, n=402; Latin America, n=80; other developing markets, n=84.

*Includes Hong Kong and Taiwan.

**Includes Middle East, North Africa, South Asia, and sub-Saharan Africa.

Source: Adapted from COVID 19 Implications for business- McKinsey& Company, Report September 2020

India as a strong nation has responded to the Hon'ble Prime Minister's clarion call to utilize this challenging crisis time as an opportunity for economic revival and promote 'Make in India' initiative towards achieving 'Atma Nirbharta'. Accordingly, TIFAC brought out White Paper on 'Focused Interventions for Make in India: Post COVID -19' in May 2020, wherein National priorities were redefined based on strength and enhanced capabilities. The white paper highlighted the need for fundamental changes in the way we act to evolve our new business models to support and strengthen our economy. It captured sector-specific strengths, market trends and opportunities in five (5) sectors, critical from country's perspective, viz. Healthcare, Machinery, ICT, Agriculture, Manufacturing, and Electronics with reference to supply and demand, self sufficiency and production capacity of technologies and products. The relative sector area strength and advantages were identified, with an understanding of market sizes, export and import trends, identification of MSME clusters and the collaborating institutions. The white paper also identified challenges, support system required for development, and defined short and long term recommendations.

Based on the linkages and interdependencies between the outputs of different sectors, along with a calculation of income according to existing data, output multiplier and income multiplier for various sectors were calculated. Higher the output multiplier for a sector, higher the need to focus on the sector towards strong 'Make in India' and 'China plus one' policy. Focusing on sectors that have a strong output multiplier and making them less dependent on imports from China would mean impact across sectors would be multiplied highly, thus helping increase the GDP value significantly.

These sectors had output multiplier and optimum income multiplier and deserved special thrust for technology intervention.

Healthcare: This sector has components that show increase in demand while limitations are projected on supply side. This calls for technology boosts using ICT and new-age technologies to make this sector a positive earner for India. However, the pandemic has brought out the limitation of our health care system more evidently. The system needs a strong impetus on Public Health Care with full inclusiveness and complete outreach of services.

Agriculture and allied sectors: The production is not as impacted as most other sectors, while the demand exists. This is a sector that is helping India in covering losses posed by other sectors. With adoption of appropriate technologies, Public Distribution System will be strengthened, post-harvest losses will be reduced and output would be augmented with mechanization of agriculture operations.

Manufacturing: Some categories of this sector are severely impacted, while not so much in other categories. The difference in impact across categories within the sector poses an interesting challenge where there may be need of shift of roles for a number of stakeholders in the sector.

ICT and Electronics: Some of the categories within the sector are showing a boost for the economy, thus creating a need for technological interventions in this sector for helping other sectors.

The White Paper had estimated that overall GDP of the country may get impacted by Rs. 14.88 Lakh Crores, if appropriate incentivization in the form of technology and finance is not done. India's GDP growth of -23.9% was the worst for April – June 2020 compared to the same period in 2019 among the G 7 economies and China. The expected imports from China in FY20 has been approximately 5% of India's GDP, value amounting to Rs. 8.5 Lakh Crores.

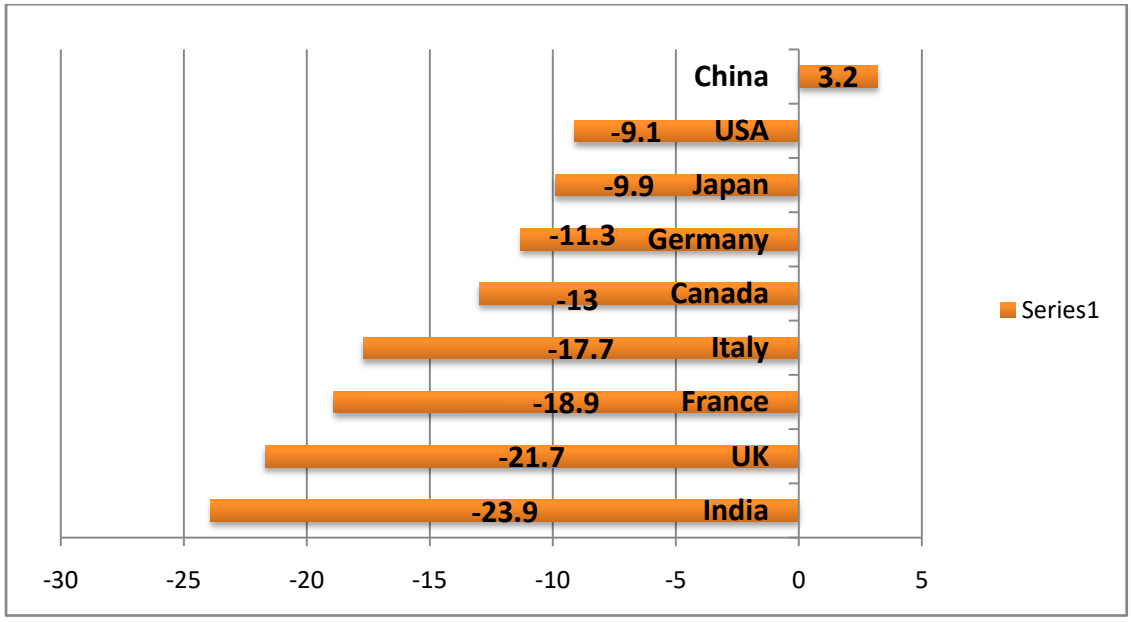


FIGURE 2: YOY GDP GROWTH (%) in April-June 2020 *vs* April-June 2019

Source: Officials GDP releases, CEIC

However, through appropriate steps, if a major portion of this import is replaced with indigenously developed products; it would significantly reduce the expected GDP loss. The same can be done by following a 'China plus one' policy driven by 'Make in India' stimulus, with Zero China Import policy for certain sectors. A stimulus of around Rs.8 Lakh Crores, distributed across sectors, focused on technology (including hardware and new age technology such as AI and data analytics), will improve India's GDP values significantly. Technology adoption/infusion would lead to higher export volumes, which would increase overall GDP.

Based on the policy shift suggestions, technology-specific recommendations have been made to accelerate India's growth during post COVID-19 scenario including: Technology clusters across India be established for homogenous job creation, technologies of mass impact, coordinate with all research institutions and pilot the technologies in the field. Understanding the importance of the rural India, efforts are put to identify affordable technologies development/downsizing/adoption for rural areas: onsite agri processing, hydroponics, aquaculture, mobile test centers, e-vehicle, distance learning & knowledge platform, extensive application of Telemedicine for outreach to rural areas on a PPP model etc.

The White Paper suggested new models for recovery of Indian economy. The design of recovery curve, post COVID-19, to be based on our national priorities and technological strength. The Paper presented a roadmap, at a macro level, on defining technology impetus required to push India, post COVID, towards self-reliance and being a global major manufacturing hub. In doing so, the paper covered, at a macro level, the needs and analysis of sectors critical to National economy, and suggests requisite policy recommendations for creating an enabling ecosystem for effecting the transformation.

Various countries have given fiscal stimulus packages in an attempt to mitigate the effects of the corona virus pandemic. These fiscal packages had different effects and not all of them were satisfactory.

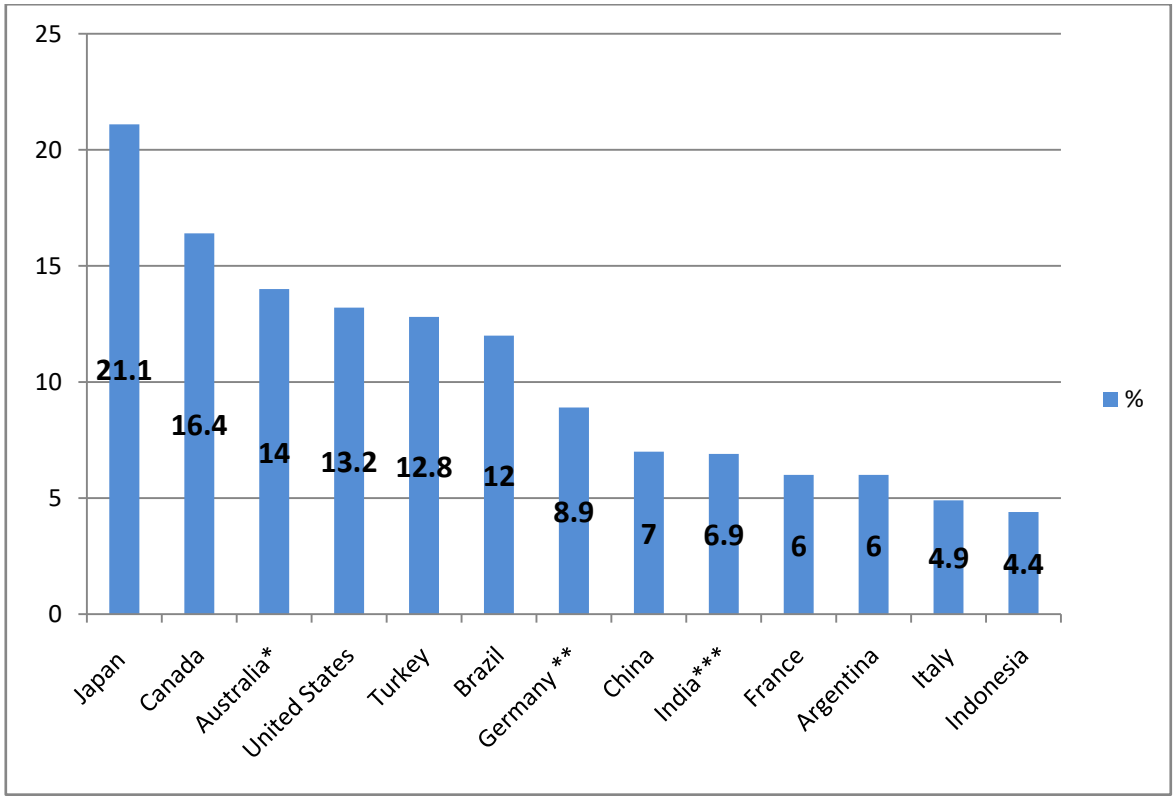


FIGURE 3: VALUE OF COVID-19 FISCAL STIMULUS PACKAGES IN G20 COUNTRIES as of October 2020, as a share of GDP

* Includes additional spending by state governments on fiscal stimulus measures, and increased spending on the health system as a result of COVID-19.
** Does not include additional 141 billion euros in direct support from states.
*** Includes additional spending on health infrastructure, but does not include government credit support to selected industries.
Published by Erin Duffin, Oct 12, 2020

As per the data released by the National Statistical Office (NSO), India's Gross Domestic Product (GDP) for the April-June quarter (Q1) slipped by a sharp 23.9 per cent. In the second quarter i.e. July to September 2020, private consumption and investments fell while government spending surged. In this quarter (July to September 2019-20), India's Gross Domestic Product grew at 4.5%. The growth was not fuelled by private consumption or investment, the prime drivers of the economy, but through government spending which surged in recent quarters.

However, sustainable efforts for stimulating the economy need policy backed innovation support, efficient management of natural resources, smarter use of materials, reduction of waste flow, creation of new opportunities etc. This would lead towards infrastructure development, creation of jobs and a sustainable economy. Studies have shown that for faster growth, countries need to have investment in cutting edge technologies; create favourable business environment, enabling innovation culture and creative workforce to bring good dividends in terms of growth, job creation and better services.

However for realizing the targets, a detailed road mapping exercise was required. Therefore, TIFAC followed up with rigorous consultation exercises and organised five thematic workshops involving different levels of stakeholders(Industry/Academia/R&D Institutions) and policy makers. The list of sector-wise participants is given in the Annexure. The detailed deliberations have been captured and presented in the following sections, as an **Action Agenda for Atma Nirbhar Bharat (AAAN).**

To further enable proper implementation planning, the recommendations have also been defined in time frames: Immediate action (0-1 year); Medium/ Long term plan (2-5 years).

To streamline the follow up actions, the policy recommendations have been categorized in the following focus areas:

- Innovation and Technology development
- Technology adoption/ diffusion
- Manufacturing and Productivity
- Trade and Globalization
- Education and Training
- Internet Policy: A.I & Data Management

The approach is three pronged:

- Sector incentivisation based on output multiplier (Amount of input needed in focused sectors, based on the value of imports)
- Technology replacement based on inherent capabilities
- New leverage creation that makes China and other countries depend on India for their inherent capabilities

India's economy, looking ahead, forges new growth avenues and builds more resilience. Apart from domestic market, India looks forward to enhance business with key trading partners, for US$ 38 billion bilateral trade opportunity. This includes a US$21.1 billion of unexplained potential that India offers to exporters in 10 diverse markets and US$ 16.8 billion opportunity for local exports to grow trade.

Policy recommendations

The policy recommendation in AAAN is a follow up to the TIFAC White Paper, considering technological imperatives and priorities in sectors crucial for our country from the socio economic perspective. The essence of this policy document is also to provide direction to governance to align and design policies for rebooting, revitalizing and providing resilience to economy post COVID. It also gives direction to the path of economic growth and sustainable development.

However to enable implementation of these recommendations, we need strong policy framework. The recommendations have been categorized for various sectors. First one, the sectoral action plans are broad and foresees specifically at a macro level. The second part defines comprehensive policy recommendations based on the understanding of the sectoral priorities.

2.0 SECTORAL ACTION PLANS

2.1 MEDICAL SCIENCES & HEALTH CARE

2.1.1 Active Pharmaceutical Ingredients

Immediate

1. Leverage & promote production of fermentation based APIs/Drug intermediates(list of APIs selected is referred in the White paper document)
2. Creation of Bulk drug/API/Clusters & Common infrastructure (ETP, steam boilers, power back-up etc.)
3. Production Linked Incentives may be explored for bulk drug manufacturers
4. Indigenous production of high value and significant ~ 25-30 Drug Intermediates (DIs), Antibiotics, Amino acids, Vitamins to be targeted initially (Pilot study, if necessary).
5. Manufacturing of fermentation based APIs at revitalized Public Sector Enterprises (PSEs) in PPP mode
   (Hindustan Antibiotics Ltd., Indian Drugs and Pharmaceuticals Ltd. etc. by leveraging domain expertise of R &D Institutes)
6. Providing shadow price analysis of APIs and market intelligence to researchers
7. Alternate locations (such as Vietnam, Indonesia, Korea etc.) shall be explored for sourcing KSMs/DIs/APIs till developing indigenous capabilities
8. Industrial /commercial production microbial strain repositories to be developed.

Medium/ Long term

1. Creation of pilot fermentation capability in collaboration with Research Institutes for scale up of fermentation-based APIs /bulk drugs.
2. Public funded GMP pilot plants to be made available for startups in API Clusters/ Bulk Drug Parks with ETP, Technological up-gradation and Quality Monitoring System (QMS), solvent recovery plant, distillation plant, power and steam units, water, utilities, drug testing labs, office of regulatory bodies, banks, etc.

3. Creation of a 'National Stockpile' towards API security in the country and ensuring uninterrupted supply, national stockpile needs to be built up for generic medicines for critical illness.
4. Drugs manufactured out of indigenously produced APIs and intermediates to be given preference in government procurements.
5. Establish single window clearance system and priority license renewal system for companies manufacturing APIs.
6. Technology access/ technology transfer/ or possible international collaboration for production of sartans, steroids, amino acids, carbohydrates, nucleosides, etc.
7. Nucleic acid building blocks along with cyanation plants (thymidine/cysteine/adenine/guanine, etc.) for economically viable and affordable antiviral drugs.

2.1.2 Biopharma, Vaccines and Diagnostics Actions

Immediate

1. Academia-industry collaboration in developing high yielding host (eg. CHO) cell line platforms/ vectors, to help Indian Biopharma productivity business remain competitive in the long run.
2. Identify bio-pharmaceuticals for products/process development and support in PPP mode and piloting such technologies, taking into consideration of the national priorities, disease prevalence in India and other social considerations of Indian masses.
3. Support the indigenous production of plasma-derived medicinal products, on priority basis.
4. Consumables such as media, feed, resins etc. currently being imported need to be produced indigenously.
5. Development of vaccine against COVID-19.

Medium /Long term

1. Manufacturing of monoclonal antibodies (mAb) /peptides to be taken on priority.
2. Implementation and validation of technologies to be developed on priority, HTPD, PAT, etc. for biopharma.
3. Reagent-grade bio-molecules, markers, and test kits should be manufactured and supplied for supporting advanced research.

4. Clinical data/ documentation to be aligned with world standards, allowing global acceptability.
5. Development of CoE for Biopharma product design and development in academic institutes in association with industries.
6. For Biopharma manufacturing in India, de-novo data generation in India should not be mandated, if a similar biopharma has already been approved in the US, Canada and the European Union
7. Harmonize Drugs Controller General of India (DCGI) with the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) to enable Indian Dossiers to be accepted overseas.
8. Support for development of vaccines against dengue, HIV, hepatitis C, Meningococcal Sero group B, Malaria, Tuberculosis, Pneumonia, Human Papilloma Virus and Gangrene.
9. Target precision engineering with respect to fast filling lines, automatic robotic controls, manning areas of filling and formulation, disposable fermenters etc.
10. Develop expertise in isolating, genetically identifying the cell-lines, authenticating the purity, and preserving the pure cell-lines. Specific national laboratories and/or IITs should be identified for this purpose.
11. Bio Pharma product zones should be created for process development and commercial manufacturing as per GMP practices
12. Developing transgenic mice initially and subsequently other humanized transgenic animals such as rats, rabbits, guinea pigs and macaques for clinical trials.
13. Establish multiple clinical and vaccine trial units approved as per GCP complications with trained manpower to carry out these trials.
14. Establishing a National Vaccine Research Center for amalgamating scientific work carried out in the area of vaccines, in collaboration with all the vaccine manufactures in the country and regulators.
15. Establishing a Centre of Excellence for development of Biopharmaceuticals, biologicals and standards.
16. Create a repository/system to enable industry for diagnostics product development in getting samples regularly for developing diagnostics tests.
17. Market India as a preferred manufacturing hub for in-vitro diagnostics.
18. Focus on predictive diagnosis by understanding molecular signal signature at gene/ cellular/ tissue level (Academia and Institutes should work as translation of technology).
19. Development of CoE for Tissue Engineering and regenerative marine products.

2.1.3 Medical Devices

(Image Courtesy: Bokskapet, Pixabay)

Immediate

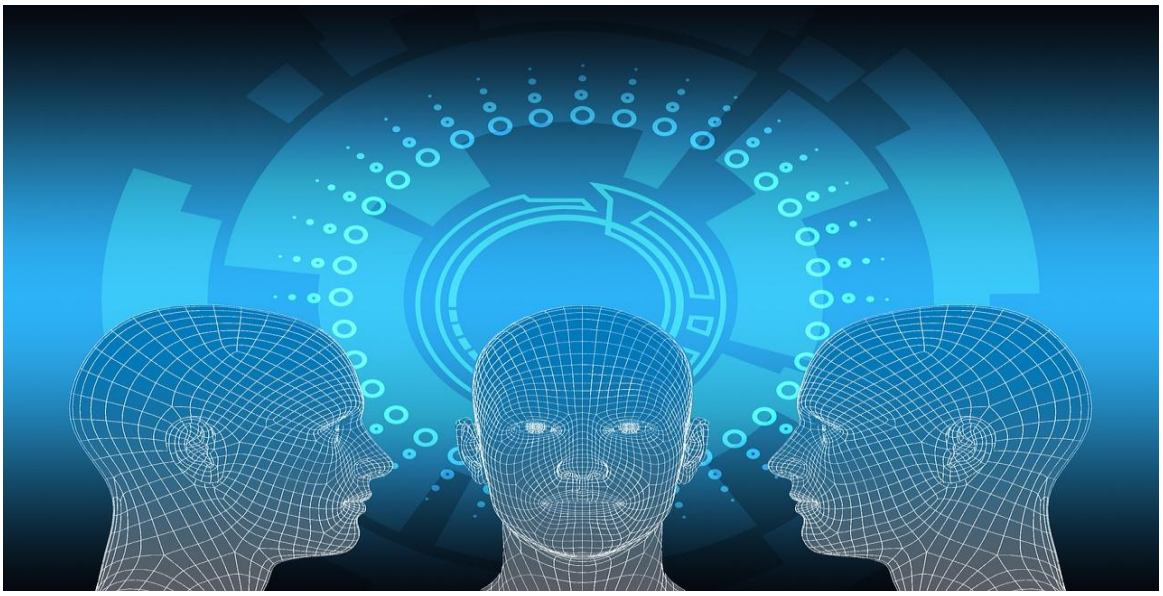
1. Support for indigenous development of Cautery, oxygen concentrator, syringe & volumetric pump, Continuous Positive Airway Pressure (CPAP) machine, Bi-level Positive Airway Pressure (BiPAP) machine, defibrillator, foetal monitor, patient monitors, modular patient monitor, anesthesia workstation, OT Table, OT lights, ICU, IVDS, ventilators, C Arm etc.)
2. Digital technology platform: Artificial Intelligence (AI), tele-consultation, and remote monitoring and development of Plug/Play model for telemedicine for remote areas and wider population be developed and validated.
3. Creation of ISO13485 facilities, and test facilities.
4. Development /Production facility of IOT sensors for health.

Medium/ Long term

1. Enhanced support for target technologies like robotics, Micro Electromechanical Systems (MEMS), 5G, 3D &4D printing, implantable nano-sensors, lab on chip, bionics, micropower, machine learning, and drones
2. Indigenization of Digital X Ray & Mammography, Ultrasound, Cath Lab, Computed Tomography, MRI, PET CT, LINAC etc.
3. Set up a centralized facility for production of materials for medical devices, preferably in the western part of India, Quality testing which could be leveraged by all smaller companies and startups.
4. Extend tax benefits to incubator companies.
5. Boost for domestic production with export subsidy of 15-20% for the next 10 years
6. Declaration of origin of manufacturing of medical devices shall be made mandatory for sale in India.
7. Transform the small and medium companies as feeder entities for the larger companies, including foreign MNCs who are willing to manufacture in India.
8. Create a strong brand image for medical devices made in India.
9. Development of nano-materials, biodegradables, MRI compatibles, and smart biomaterials to be supported.

10. Development of processes for connected health (patient centric healthcare, Internet of medical things, augmented reality and virtual reality), tissue engineered products, wound management, and bio-mimic products, to be supported extensively.
11. Indigenous manufacturing of heart lung machines, Extracorporeal Membrane Oxygenation (ECMO) machines, portable dialysis, Transcatheter Aortic Valve Replacement (TAVR), Intra-cardiac ventricular assist device, personal respirator, cytokine storm detector, etc.
12. Creation of about 5-6 medical devices manufacturing park, in the lines of Andhra Pradesh Medtech Zone Ltd.(AMTZ).
13. Establish at least two industrial parks for manufacturing diagnostic equipment. In these parks, land should be made available on a nominal cost to the manufacturers and centralized facilities such as quality control laboratory, cold room facility, effluent treatment plant, bio-waste management, and a common R&D facility with all necessary equipment should be provided.

2.2 INFORMATION & COMMUNICATION TECHNOLOGY



Post COVID ICT sector has shown immense potential in bridging the digital divide and ushering digital transformation. ICT has exhibited deep involvement in all sectors of economy. AI has potential to empower people at the bottom of the pyramid, address financial inclusion of people and as per an estimate, contribute a trillion dollars to the Indian economy. Equal digital access is even more crucial especially in a pandemic situation to ensure equitable distribution of social and economic welfare measures.Developed countries have recognized the importance of data driven economy and need for putting in place a comprehensive data policy. Our Hon'ble Prime Minister has also underlined the importance of AI and said that artificial intelligence (AI) can play a crucial role in developing solutions in agriculture, creating next generation urban infrastructure, as well as for making disaster management systems in the country stronger. Prime Minister has further stated he wants India to become a global hub for AI.

The potential in India is huge as we have around 700 million internet users and around further 600 million potential users with fibre based internet reaching six lakhs villages over the next 3-5 years. The mantra for India is to develop AI bottom up drive for financial inclusion and ensure social empowerment. In this endeavour, R&D in exponential technologies like AI, Cloud, Robotics etc, has to be prioritized. In all these, Availability of data is the key enabler for exponential technologies. Stress also needs to be given for MSME sector and start ups an upgrade to these technologies. Centre needs to be created for quantum computing, cloud computing and cyber security.

Immediate

1. High speed seamless affordable broadband connectivity with incremental frequency upto 26 Ghz and extended network of optical cable fibre.
2. India needs to set up operational standards for 5- G. Need to create standard setting groups with reference to EU standards.
3. Prioritize data, data analytics for data driven governance
4. Providing access to hardware especially for low income groups by making available hardware network.
5. Skilling population for digital skills and enabling remote learning
6. Short term training programs be designed for cloud computing and cyber security.
7. Development of Open Radio Access Network (ORAN) to enable hardware of different companies to work in synchronization.
8. Massive AI literacy program

Medium/ Long Term

1. Development of Low cost assistive devices like Alternative augmented communication devices, text to speech etc.
2. Multi-lingual platform and e-books (to track performance) using Speech tech., AI, ML, NLP etc.
3. Remote (non -invasive) diagnostics, online health monitoring& delivery using AI, Blockchain virtual doctors, chatbots etc.
4. Real-time language translation and Voice-recognition system enabled with AI, Speech Tech. NLP, Edge cloud computing.
5. Segregated cyber security protocols for data handling for different sectors.
6. Focus on cyber security protocols with reference to penetration testing and patching.
7. A coordinated approach based on robust security concepts in tandem with EV tool for 5G cyber security.
8. India should develop and secure cloud for Government of India's strategic data.

2.3 AGRICULTURE & FOOD PROCESSING SECTOR

Immediate

- Linking of Mandis to Electronic National Agriculture Market (e-NAM) by networking with existing Agricultural Produce & Livestock Market Committee (APMCs).
- Identifying and designing agri-processing & handling zones (APHZ) with reference to agri-product /storage and trading.
- Promotion of Bloom sprayers and atomizer irrigation technologies.
- Launching of Nationwide Mission Mode Programme on 'More crop per drop'.
- Establishment /creation of Custom Hiring Centres (CHC) for Agri-machinery in Ola/Uber model across India.
- Expanding sea cage farming.
- Improving Potential Fishing Zone (PFZ) advisories.
- Deploying Fish Aggregating Devices (FADs) and strengthening Vessel Monitoring System and sea safety.
- Promoting seaweed farming.

Medium/Long-term

- Promotion of fortified millets and coarse cereals to improve nutrition status.
- Making fortified millets and coarse cereals available through PDS, mid-day meal and other food distribution schemes.
- Promotion and use of drones for farm activities.
- Designation of export promotion zones with necessary infrastructure such as cold storage, processing and grading facilities.
- Rapid detection of diseases and management of zoonotic diseases and epidemics and demonstration of mobile testing kits/sensors.
- Establishment of around 100 Agri-Processing Zones (APZs) in PPP mode in select locations catering to exclusive agriculture production areas across various potential areas in India.

- Establishment of Bio Fortification Research Centre and mainstreaming of bio-fortification in the national plant breeding programs.
- Establishment of exclusive Marine –based nutraceutical production centres in potential zones in India.
- Exploration of alternative water sources like use of treated sea water for irrigation.
- Promotion and use of Autonomous tractors and advanced swarm robots.
- Industrialisation of agriculture with data security and potential price benefits.
- Development of Lab-on-chip for detection of zoonotic diseases.
- Robotic milking systems that enable cost-effective, uniform milking and post-milking procedures.
- Accelerate genetic improvement in livestock through advanced reproductive technologies & precision breeding.
- Identification and development of stress resilient genotypes.
- National Mission on Climate Smart Agriculture (NMCSA).

2.4 MACHINE TOOLS &MANUFACTURING

2.4 Machinery and Manufacturing

The regressive globalization and supply chain disruptions, post COVID-19, has given India an opportunity to position itself as an alternate global manufacturing hub. Some target segments are (a) Critical Equipments / Machinery which are being imported from China; (b) Raw Material sourcing in areas of renewable energy e.g semiconductors, inverters, photovoltaic cells etc. and (c) Cutting, Drilling CNC and Robotic machinery for Indian Railways and Infrastructure sector. However, as per industry data, high-end machine tools are still majorly imported in India. It is estimated that India imported machine tools valued at around Rs 24,700 crore during the fiscal year 2019.With the Government of India's push on 'Make in India' and 'Atmanirbharta', the spotlight is on the Indian Manufacturing sector.

Indian machine tools industry would play the role of catalyst in realizing the country's manufacturing vision

Immediate

- Indigenous development of following machines for higher efficiency precision manufacturing locally :
- CNC controllers for lathes, grinders, cutters, turn-mill machines with multi tasking abilities for grinding, gear cutting, hardening operations etc.
- Promotion of 3D printing centres for prototyping and designing.
- To create Centers of Product Development (CPDs) to be equipped with design, manufacture, assembly and testing infrastructure along with requisite laboratory infrastructure.

Medium/ Long Term

- Support to be given for indigenous production of precision plasma steel cutting system with robotics for 2D and 3D cutting job.
- 5 axis ultrasonic CNC machine design.
- Focus on developing C-type Machine to optimize machine structure and ribs distribution for stable machining precision on cutting.
- Dry gear hobbing and multiple diameter gear shaping machines with high cutting rates
- Direct-coupled Servo Motor to ensure accuracy in micro-feeding and torsional rigidity.
- Automatic Winding Switch to keep high torque output in high speed machining for better machining efficiency.
- Electrical machining technologies such as electro-discharge machines (edm), wire-edm, electrochemical machines to be supported and developed for industries such as die and mould, defence, instrumentation, medical, optical, electronics, toys industries besides
- Rapid manufacturing of turbine component using Electron beeam Melting
- Usage of novel alloys for their effect on ductility and strength.
- Integrated industrial infrastructure facilities to be developed.
- Make optimal use of Additive Manufacturing technologies (AAA+) by increasing demand for customisation by consumers and value chain partners.
- Provide incentives for acquisition of advanced technologies to strengthen country's technological capabilities by way of deductions under Income Tax Act, Custom duties exemption and also specific subsidization.
- India should focus on providing capital subsidy to SME units to promote the manufacturing of quality products. Also, a cluster-based approach is needed to create common facilities like testing, skill development centres and tool rooms, preferably by the Centre or state governments.
- Technology support &Intervention in MSME Clusters through proximate Academic Institutions.
- New Skill development centres on PPP mode in modern machines and tools, machine repair so as to reduce wastage for circular economy.
- Create common engineering facility centres for testing and certification for machining/manufacturing tools.
- Create ecosystem for propagation of Industry 4.0 by every Indian manufacturers by 2025.

2.4.2 Solar PV

India has set a target of deploying 100 GW of solar energy by 2022 and 300 GW by 2030. To reach the targets, about 15-30 GW of solar energy would need to be deployed every year for the next 10 years. Out of 500,000 tons of poly-silicon, the main raw material for Solar PV cells, being currently manufactured worldwide, 80% is produced by China and from polysilicon to wafers, 95% is made in China. India is still buying wafers & basic materials for manufacturing of solar PV cells.

Immediate

- Poly silicon wafers manufacturing facility be created / supported.
- Development of indigenous technologies for organic/polymer solar cells, thin film solar cells, Dye sensitized solar cell, Perovskite cell with higher efficiencies.
- Special Incentive Package (SIPs) policy to promote PV manufacturing plants, including domestic manufacture of silicon material.

Medium / Long term

- Setting up of Solar Equipment Parks with integrated manufacturing plant for polysilicon to wafers to solar cells and modules for a good solar eco-system starting from glass, gases, polymers, pastes, monitoring equipments, inverters etc.
- India's huge availability of good quality quartzite with low Boron content needs to be tapped as raw material for the production of polysilicon/wafers
- India to have technology tie-up with Germany & USA who hold the technology for manufacturing of polysilicon through the existing bilateral channels of Indo-EU, Indo-German and Indo-US to get the technology licensing.

2.4.3 Textile machinery sector

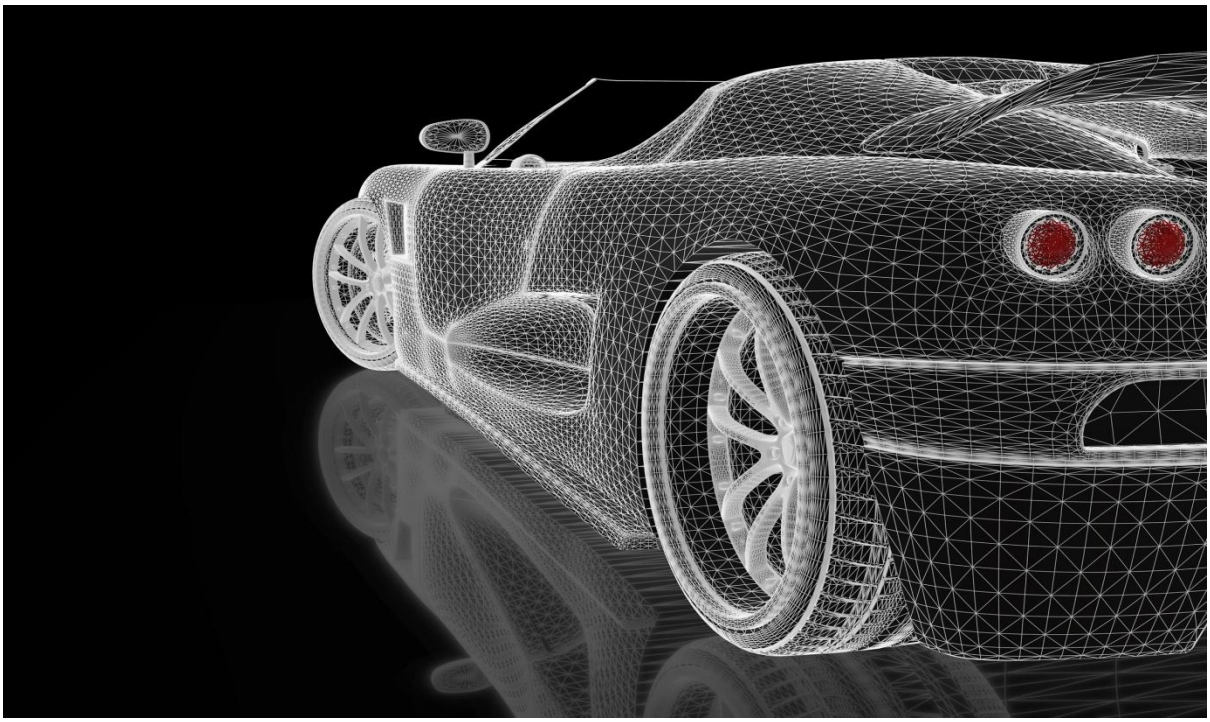
Immediate

- Indigenous manufacturing of high speed shuttle less power loom
- Indigenous design and manufacturing of electronic jacquard along with local spare parts
- Indigenous manufacturing of automatic Silk Reeling machines to produce 4A grade filament for use on high speed power looms
- Manufacturing of specialized coating and lamination machines for technical textiles
- Application of CAD based design for textiles in MSME sector

Medium / Long term

- Indigenous development of machinery for digital printing of silk
- Focus on low cost production of specialty fibres such as carbon fibres, Nylon 66, UHMPE, Poly acrylic fibres etc.
- Development of eco friendly dyes/ mordant without use of Ni and Cr
- Establishment of Common Facilitation Centres (CoEs) to facilitate conceptualization and implementation for projects, training of technical staff of manufacturers, organizing workshops and seminars, facilitation in obtaining government subsidies for projects, etc.
- Strong tie up of textile machinery industry with Research & Development Institutions to make them export competitive
- Establishment of Large scale clusters for production of technical textile machinery

2.4.4 Automotive Sector



(Image courtesy: Tayeb MEZHADIA, Pixabay)

Recent adoption of BS-VI norms, new safety norms and a thrust towards sustainable alternatives, specifically electric mobility, are major imperatives for the automotive sector. There is significant amount of import dependence not only for electric vehicle components, but for conventional IC engine vehicles components also. India still imports many key components, including even measuring instruments.

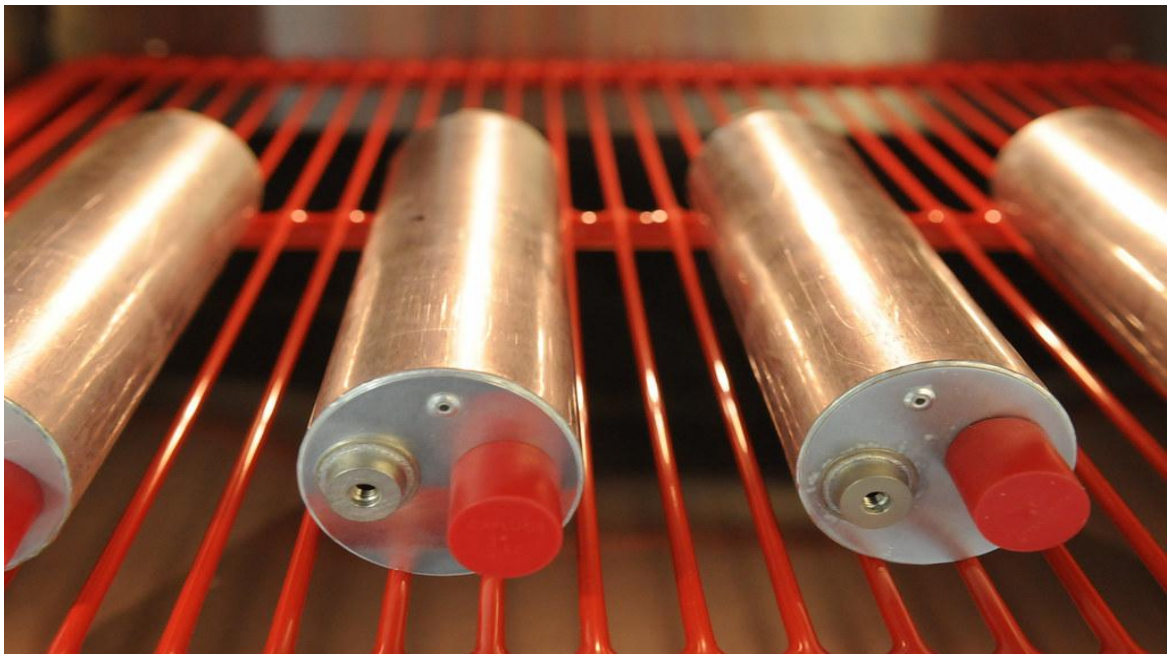
Immediate

- Improvement in conventional IC engine vehicles: better combustion/ engine technologies (Variable Valve Timing, Turbocharging, Exhaust Gas Recirculation etc), after treatment (SCR, DPF etc) and control system. Scope of improvement is particularly high in heavy duty vehicles.
- Development of low cost electric vehicle charging systems taking into consideration the requirements at the Indian conditions and characteristics of Indian vehicles.
- Use of block chain oriented battery charging/ battery swapping systems; application of artificial intelligence to find the best method for fast charging a battery to increase its lifetime.
- Creation of a roadmap on future test infrastructure and homologation requirements keeping in view the emerging clean mobility technologies. ARAI/ NATRIP, auto industry and TIFAC should work together towards creation of such a roadmap.
- Training and skill development in the areas of maintenance and repair /remanufacturing of vehicles using emerging technologies like IoT, software algorithm, Artificial Intelligence and Machine Learning
- Support through technology acquisition Technology Acquisition Fund Program (TAFP).

Medium/ Long Term

- Development of technology for extraction of rare earth materials, fabrication of rare earth permanent magnets for PMSM/ BLDC motors
- Development of wide bandgap semiconductor (GaN and SiC) based power electronics solutions for electric vehicles, and development of wide bandgap semiconductor devices.
- Automation and Digitalization in vehicle and component design to leverage IoT capabilities in gear, steering , braking system etc.(MSME In collaboration with big industries)
- Programme to promote indigenous manufacturing of automotive components ensuring that such manufacturing achieve the scale of economic viability across manufacturers.
- Collaboration with Japan for technologies on extraction/ processing of Indian rare earth materials and production of rare earth permanent magnets.
- Development of Centres using IoT tools for on board diagnostics of automobiles for engine performance in PPP mode.
- Development of a National Centte for Automotive and Aerospace Vehicles
- Support be extended for following:
  - Integrated Industrial Infrastructure facilities
  - Common Engineering Facility Centres
  - Test and Certification Centres

2.4.5 Energy Storage Technologies



A study by India Smart Grid Forum (ISGF) and India Energy Storage Alliance (IESA) has projected the demand for energy storage systems in various applications by the year 2032 could be 2416 GWh, including 1414 GWh for electric vehicles and 1002 GWh for stationary applications. There is a distinct trend towards more electrochemical energy storage devices, and particularly towards lithium ion battery. There was a fourfold increase in the import of lithium ion battery during 2016-2018, with figure jumping from 175 million batteries in 2016 to 712 million batteries in 2018. It is important for India not only to ensure

indigenous manufacturing of lithium ion battery, but also to develop competency in other emerging options that offer advantages of resource availability, cost, safety etc.

Immediate

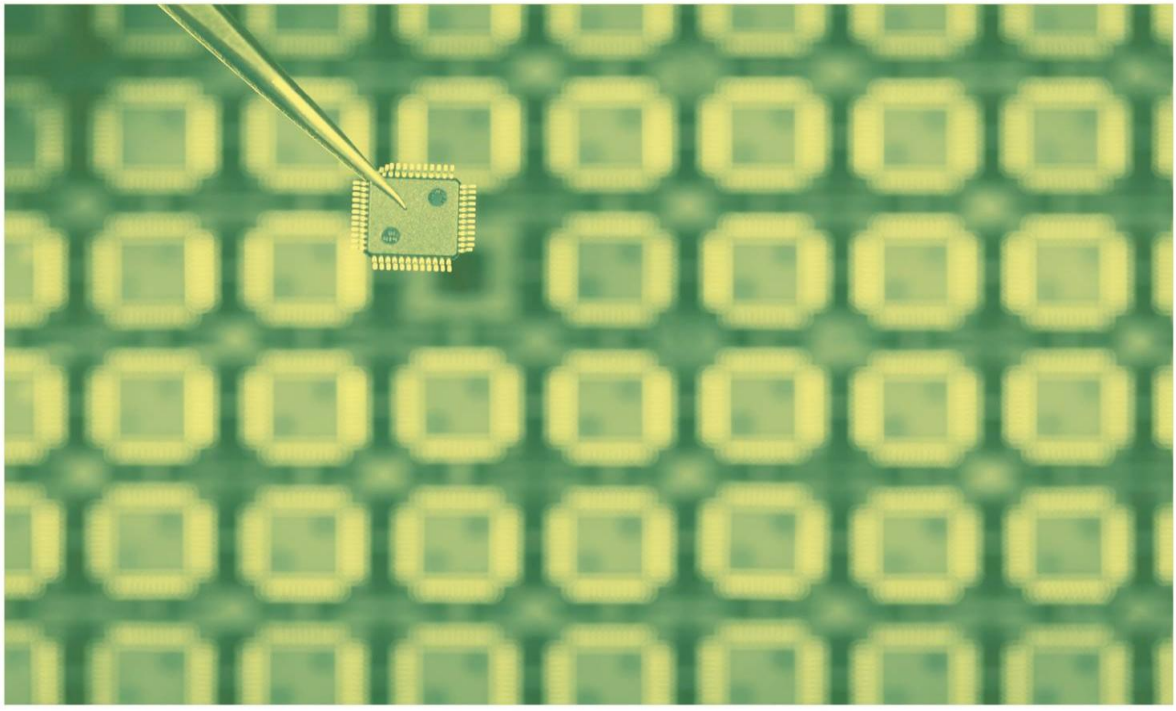
- Scaling up lithium ion technology available at laboratory scale with appropriate cell manufacturing technology and manufacturing equipment.
- Indigenous Manufacturing of Materials/ components of Lithium Ion cells such as electrode materials, electrolyte, current collectors, and separators.

Medium/ Long Term

Development & commercialization of novel energy storage / battery technologies:

- Lithium ion recycling.
- Na-ion
- Super capacitors that offer much higher energy storage capability
- Redox Flow Battery (application for grid level storage)
- A centre of excellence on electrochemical energy storage may be set up in hub and spoke model involving major R&D institutions, academic institutions and industry as partners.
- Identification and support to start ups of various segments of lithium ion value chain
- Encouraging companies from South Korea , Japan, for setting up manufacturing facility for lithium ion battery.
- Standards to be developed for second use/ recycling of lithium ion and emerging battery.
- Strategic partnerships for sourcing of lithium with countries with lithium resources such as Bolivia, Chile, Argentina etc.

2.5 ELECTRONICS



Current contribution (pre -COVID) of Electronics sector on GDP of India is 2.5 % but having potential for far greater share. The focus to be on sectors of: Mobile phones, medical

electronics, consumer electronics, automotive electronics, Information Technology, IOT & Artificial Intelligence, and Telecommunication. Further as brought out in the White Paper, electronics sector has an output multiplier of around 2.35 thus reflecting need for a strong focus. The Government has adopted a new National Policy on Electronics 2019 and also initiated programmes like Productivity Linked Incentives (PLI), Promotion of Electronic Components and Semiconductors (SPECS) and Electronics Manufacturing Clusters 2.0 (EMC2). Development of competency at the component level and semiconductor manufacturing can move Indian electronics industry towards achieving higher level of value addition.

Immediate Term

1. Development of indigenous technology for Printed Circuit Board Assembly (PCBA), display, battery etc.
2. Manufacturing of routers, switches, optical fibres etc & peripheral electronic equipment for broad band connectivity.
3. Encouraging global component vendors from newer post COVID re aligned countries to set up manufacturing facilities in India.
4. Application based learning and skill development on semiconductor design and manufacturing to be supported.

Medium/ Long Term

1. Indigenous production of capital equipment for electronics manufacturing, such as surface mount technology (SMT), machine vision systems etc.
2. Indigenous production of components for mobile phones
3. Initiatives for production of micro-electro-mechanical systems (MEMS) and sensors, light-emitting diode (LED) and flexible display technologies for 5G, IoT and IIoT.
4. Hardware devices for 5G technologies: Supporting would require a wide range of advanced methods from directional signals to MIMO antennas.
5. Semiconductor Manufacturing: Focussed support for development/manufacturing semiconductor & IC fabrication facility
6. Development and testing and certification laboratories for 5G telecom products.
7. Mission mode support for large scale telecommunication products in India.
8. Design and development of functional robots at identified centres.
9. Develop an ecosystem for chip design and development in which start-ups, R&D institutions and academia can actively participate in association with Indian industry. Innovation in new semi-conductor materials needs to be encouraged.
10. Promotion and incentivization of IoT sensors production and exports.

3.0 BROAD POLICY RECOMMENDATIONS

3.1 Innovation and Technology Development

1. Development of **Phase Zero Programme** for supporting proof of concept to cross the valley of death from early stage research to commercialization by providing necessary infrastructure expertise and personnel, incubation and accelerator facilities
2. **Innovation Voucher** be created and provided to micro small enterprises to but expertise from Universities and National Lab Research Institutions to conduct studies, analyse the innovation potential of new technologies.
3. Companies (Indian start ups) to pay a lower tax rate on income generated from innovation based products including incentive to conduct R&D in companies.
4. Small Research Company be allowed to carry their net operating losses forward.
5. Using AI to reshape product development cycles, improve product design processes, reduce defects and deliver products faster to the market.
6. Incentive be provided to put up a semiconductor manufacturing facility for indigenous use.

3.2 Technology Adoption/ Diffusion

1. Creation of Tech Acceleration Hub, supported by Government for the Promotion of technology transfer and upscale commercialization.
2. Creation of a new programme: I-Fund to promote entrepreneurship which may lead to commercialization of technology that that has been developed through SERB-DST-DBT etc.
3. Necessary support be provided for promotion of modern contemporary technologies from countries like Israel, Japan and U.S for necessary adoption/ diffusion at all manufacturing scale including start ups.
4. Promotion/Adoption of Fin-tech Technologies.
5. Use of AI/Blockchain at various levels of technology translation and pilot stage
6. Technology transfer and diffusion Centre be created in technology Institutes to support technology transfer to start ups.
7. Development of AR/VR to give immersive experience at all levels of applications.
8. Usage of block chain technology for enhancing the reach of medical healthcare and making it all inclusive.
9. Wide adoption of telemedicine (plug and play model) to make medicare reach out to inaccessible terrains, and to the poorest of poor.
10. Scheme for technology utilisation from off-patents and inventions not patented in India.

3.3 Manufacturing and Productivity

1. Reduce waste by collecting and compositing food residues and recycling nutrients as production inputs
2. Government should initiate programme in technology overall to deliver greater value that increase productivity.

3. Reshoring incentive fund to be creative to provide financial support for Firms in critical industries to relocate production now in China to India.
4. Adoption of Circular Economy Strategy
5. National Manufacturing Strategy to develop to support "Make in India". Funds to be provided to states for assisting them to develop and execute manufacturing program. More manufacturing industries to be created, manufacturing innovation to launch focus on technology, including additive manufacturing, digital manufacturing, design innovation, lightweight composites (PV cells, storage batteries, integrated photonics, revolutionary fibres and textiles, robotics and biopharmaceutical manufacturing.
6. Government should ban the import of second-hand machine and manufacturing tools.
7. Create eco system for propagation of Industry 4.0 in every manufacturing/ production unit by 2025.

3.4 Trade and Globalization

1. Reshoring incentive fund to provide financial support to Companies is critical, for relocating production from China to India (life sciences/Health/IT/ Machinery/Electronics).
2. Create an office of Competitive trade to Ministry of Commerce to fight the crucial war against innate mercantilist fueled by non tariff barriers, IP coercion, theft and discriminatory Industrial policies (WTO disputes).
3. Exemption of New Business younger than 2 years old from regulation
4. Simplified credit for R&D startups and companies, including amortization of patents and IP.
5. Creation of Indian Economy Competitive Commission for evolving and supporting in trade sector including manufacturing. This Commission should also promote long term investment in innovation.
6. Create Global Knowledge Investment Zones to attract FDI in and around Research/Academic Institutes of importance (Varanasi, Nasik, Guwahati, Mysore, Indore)
7. Introduce financial incentives for regenerative practices (eg. payment for ecosystem services) and revisit subsidies and quotas (fossil fuels, biofuels) that lead to inefficiencies, water depletion and land degradation.
8. Development of Policy and incentivization for indigenous production and supporting export of electronic chips, devices, sensors and hardware.
9. Exemption from IP encumbrance of COVID -19 specific technologies by listing and notification for two years.

3.5 Education and training

1. Lab-Embedded Entrepreneurship Programme (LEEP) to provide entrepreneurship access to the advanced technology equipment and know-how that the labs possess for eco development in job creation
2. Academic / Researchers should be allowed and permitted to work in Industries for fix duration of time.
3. Workforce training and Capacity building programs and mandatory skilling exercise for all graduates.

4. IT enabled training should be provided and certificates to be given at all levels of jobs.
5. Creation of Rural Innovation Institutes to support activities related to aquaculture, agriculture, wind energy and food processing etc.
6. The mandate of Industrial Training Institutes (ITI) to be refocused towards training in contemporary IT domains/ manufacturing processes (Industry 4.0)
7. Application based learning in higher education system is required. Talent pool for highly skilled areas such as semiconductor design and manufacturing needs to be developed.

3.6 Internet policy and data management

1. India should make policies around collection of big data (anonymized) coming in from the usage of varying consumer electronics and industrial electronic products.
2. Generation and management of e- health data of Indian population.
3. Understanding and appreciation of concept on data security.
4. Develop and adopt standards and architecture for ICT devices and protocols
5. Setting of India Data Center, Indian Cloud and Data Regulatory Authority at various levels.

4.0 CONCLUSION

Hon'ble Prime Minister has urged Indians to be vocal for local. He has also asked Indians to appreciate local products so that the manufacturers get encouraged. Prime Minister has further highlighted that last year there was 18 % increase in FDI to Country reflecting the growing global confidence in us. However to sustain the momentum, it is necessary that we bring transformational changes in the way we work especially in context of requisite technologies and enabling policies.

AAAN has brought out the sectoral imperatives and action agenda for five sectors namely: Healthcare, Machinery, ICT, Agriculture, Manufacturing, and Electronics. These sectors are critical to Country's overall development. The action agenda was structured by following up the White Paper: **Focused Interventions for "Make in India": Post COVID -19** with brainstorming workshops in each of the five recommended sectors. The sectoral workshops were enriched with the participation of leading experts from Industry, Academia, R&D Institutes and Policy makers. The detailed deliberations of the brainstorming sessions (total 9) have been presented, sector wise, in this comprehensive report **Action Agenda for an Atma Nirbhar Bharat** (AAAN).

Indian government has already taken a host of measures and policy decisions to make India an investor friendly destination but lot more needs to be done to meet the new challenges posed by the pandemic and to harvest the investor sentiments looking for safe investment destinations. Obviously investments are needed in strategic sectors. The Investments should not be expected only from MNCs but the eco system should be such so as to facilitate investments flow from SMEs and MSMEs too. AAAN has also emphasised on the need for investing majorly in innovation, technology transfer and translation. Countries like China and US dominate the global market primarily due to their large bank of IPs. If India has to compete on the global scale, we need to ramp up domestic innovation with IP mandate and in house capacity building for manufacturing.

AAAN in all sectoral recommendations has majorly emphasized establishment of Centres of Excellence in academic Institutes for research and development and piloting of novel technologies for indigenous production. It has also stressed for development of PPP mode for establishing Special Zones and parks for identified products and processes. These parks to be equipped with necessary infrastructure, testing labs, financial Institutes and offices of regulatory bodies if any. AAAN has summarily emphasized that the focus shall not be restricted to Science and Technology but rather for **Science, Technology and Economy**. Focus is also on enabling agriculture not only for **enhancing productivity but also for profitability.** Stress is also given for supporting and utilization of upcoming technologies like 5G, IoT, AI & machine learning, across all sectors.

This is a road map for Local to Global and to enable leapfrogging our Country to **"Atma Nirbharta".**

ANNEXURE

(List of participants of the thematic workshops)

1 a) Biopharma, Vaccines, Diagnostics (meeting held on 18th August, 2020)

S No	Name	Affiliation
1	Dr. Amulya K. Panda	Director, National Institute of Immunology, New Delhi
2	Dr. S. Eswara Reddy	Joint Drugs Controller (India), CDSO
3	Dr. Raman R. Gangakhedkar	Dr C.G. Pandit National Chair, ICMR
4	Dr. P. K. Ghosh	Former Adviser, Dept. of Biotechnology, Govt. of India
5	Dr. Ashok Kumar	President, Centre for R&D, Ipca Laboratories
6	Dr. Krishna Mohan	AVP, VINS Bioproducts Ltd.
7	Dr. Dakshesh V. Mehta	Associate Vice President, Wockhardt Research Center
8	Dr. Rajeev M. Dhere	Executive Director - R&D, Serum Institute of India Ltd
9	Dr. Ranjeet S. Ajmani	CEO, PlasmaGen Biosciences Pvt. Ltd.
10	Dr. Rama S. Verma	Professor, Dept. of Biotechnology, IIT Madras
11	Dr. Anurag S. Rathore	Professor, Dept. of Chemical Engineering, IIT-Delhi
12	Dr. Raghavan Varadarajan	Professor, Molecular Biophysics Unit, IISc, Bangalore
13	Mr. Shailendra Kawade	Executive Director, Mylab Discovery Solutions Pvt. Ltd
14	Dr. Mahesh K. Bhalgat	Chief Operating Officer, Syngene International Limited
15	Ms. Veena Kohli	CEO, Vanguard Diagnostics Pvt. Ltd.
16	Mr. Jatin Mahajan	Managing Director, J. Mitra & Co. Pvt. Ltd.
17	Dr. Anoop Kumar T.	Scientist 'G', SCTIMS, Trivandrum
18	Dr. Wahajuddin M.	Principal Scientist, Central Drug Research Institute, Lucknow
19	Dr. Krishnan H. Harshan	Principal Scientist, CCMB, Hyderabad
20	Dr. Sumit Gandhi	Principal Scientist, Indian Institute of Integrative Medicine
21	Dr. Kavita Singh	Mission Director -National Biopharma Mission, BIRAC
22	Dr. Jyoti M Logani	Scientist – E, Dept. of Biotechnology, Govt. of India
23	Dr. Geeta Rai	Associate Professor, IIT–BHU
24	Dr. Rahul S. Bhambure	Senior Scientist, National Chemical Laboratory, Pune
25	Dr. Asha Chaubey	Sr. Scientist, Indian Institute of Integrative Medicine, Jammu
26	Dr. Rajkishor Rai	Sr. Scientist, Indian Institute of Integrative Medicine, Jammu
27	Dr. Hardeep Vora	Programme Manager, BIRAC
28	Dr. Mirage Singh	Programme Manager, BIRAC
29	Dr. Shikha Malik	Programme Manager, BIRAC
30	Dr. Pradeep Srivastava	Executive Director, TIFAC
31	Mr. Sanjay Singh	Scientist 'G', TIFAC
32	Mr. Basak P R	Scientist 'G', TIFAC
33	Dr. Gautam Goswami	Scientist 'G', TIFAC
34	Mr. Arghya Sardar	Scientist 'F', TIFAC
35	Mr. Chandrasekhar T	Scientist 'F', TIFAC
36	Dr. Debabrata Majumder	Scientist 'F', TIFAC
37	Ms. Jancy A	Scientist 'F', TIFAC
38	Ms. Nirmala Kaushik	Scientist 'F', TIFAC
39	Ms. Sangeeta Baksi	Scientist 'F', TIFAC

40	Ms. Sangeeta Nagar	Scientist 'F', TIFAC
41	Dr. Yashawant Dev Panwar	Scientist 'F', TIFAC
42	Dr. Shishir Kumar Goel	Scientist 'E', TIFAC
43	Dr. Chakradhar T	Scientist 'C', TIFAC
44	Ms. Mukti Prasad	Scientist 'C', TIFAC
45	Dr. P K Anil Kumar	Scientist 'C', TIFAC
46	Mr. Manish Kumar	Scientist 'B', TIFAC
47	Dr. Aruna Tiwary	IPR Scientist, TIFAC
48	Ms. Dipti	PFC, TIFAC

1b) Active Pharmaceutical Ingredients (meeting held on 17th June, 2020)

S No.	Name	Affiliation
1.	Dr Dinesh Dua	Chairman – Pharmexcil & Executive Director Nectar Lifesciences Limited, Chandigarh
2.	Dr Shreerang Joshi	Head- Dept. of Pharmaceutical Sciences & Technology, Institute of Chemical Technology, Mumbai
3.	Dr Raghvendra Gaikaiwari	Chairman &Managing Director, Hi Tech Bio Sciences India Ltd., Pune
4.	Dr Maneesh Kashyap	Scientist –I, NIPER, SAS Nagar, Mohali
5.	Dr Hemanth Nandigala	Director, Virchow Biotech (P) Ltd, Hyderabad
6.	Mr Amrish Shah	Head – Purchase (RM & PM), Alembic Pharmaceuticals Ltd, Vadodara
7.	Mr Kiran Modi	Managing Partner, Riddhi Pharma Ltd, Ankleshwar
8.	Dr Dinesh Kumar	Assistant Professor, NIPER Ahmedabad
9.	Dr Mamta Sharma	Director, Agati Healthcare Pvt Ltd, Navi Mumbai
10.	Mr S Srinivasan	Managing Director, Srikem Laboratories Pvt Ltd, Navi Mumbai
11.	Dr Mahendra Savadikar	Head – Business Development, Hi Tech Bio Sciences India Ltd., Pune
12.	Dr Girish Khandekar	Expert API
13.	Dr Vilas Dahanukar	Director R&D, Bioxera Pharma Research LLP, Pune
14.	Dr. Dattahari Dash	Vice President, Corp. Quality Assurance, Intas Pharmaceuticals Ltd., Ahmedabad

TIFAC Team

S No.	Name	Affiliation
1.	Dr Pradeep Srivastava	Executive Director
2.	Mr Sanjay Singh	Scientist 'G'
3.	Ms Nirmala Kaushik	Scientist 'F'
4.	Dr Yashawant Dev Panwar	Scientist 'F'
5.	Mr Rahul Kumar	Scientist 'E'
6.	Dr P K Anil Kumar	Scientist 'C'

I c) Medical Devices (meeting held on 18th August, 2020)

S No	Name	Affiliation
1	Dr. Jitendra Sharma	CEO - Andhra Pradesh Medtech Zone Ltd.
2	Mr. Rajiv Nath	Forum Coordinator, Association of Indian Medical Device Industry
3	Dr. Nagesh D. S.	Scientist 'G', SCTIMST, Trivandrum
4	Mr. Sunil Khurana	BPL Medical Technologies Pvt. Ltd.
5	Mr. Siddhartha Bhattacharya	Secretary-General, Healthcare Federation of India
6	Dr. Kingshuk Poddar	Tata Steel
7	Dr. A. R. Nitin Rao	M.S. Ramaiah Memorial Hospital, Bangalore
8	Mr. Prasad Kulkarni	CEO, Prasaditi Medical Equipments
9	Dr. Bhuvaneshwar G. S.	Consultant, Medical Devices
10	Dr. Kalaivani Ganesan	Scientist 'E', Dept. of Biotechnology, Govt. of India
11	Dr. Veena P. Waiker	M.S. Ramaiah Medical College, Bangalore
12	Mr. Pradeep Kumar K P	Project Engineer, M. S. Ramaiah University of Applied Sciences
13	Mr. Chandru P Kulkarni	Project Engineer, M. S. Ramaiah University of Applied Sciences
14	Mr. Parikshith N	Technical Manager, M. S. Ramaiah University of Applied Sciences
15	Mr. Karamchand K	Executive, M. S. Ramaiah University of Applied Sciences
16	Mr. Harshavardana B H	M. S. Ramaiah University of Applied Sciences
17	Mr. Nagaraja B	M. S. Ramaiah University of Applied Sciences
18	Mr. Shrideep	M. S. Ramaiah University of Applied Sciences
19	Dr. Pradeep Srivastava	Executive Director, TIFAC
20	Mr. Sanjay Singh	Scientist 'G', TIFAC
21	Mr. Basak P. R.	Scientist 'G', TIFAC
22	Mr. Arghya Sardar	Scientist 'F', TIFAC
23	Mr. Chandrasekhar T.	Scientist 'F', TIFAC
24	Dr. Debabrata Majumder	Scientist 'F', TIFAC
25	Ms. Nirmala Kaushik	Scientist 'F', TIFAC
26	Ms. Sangeeta Baksi	Scientist 'F', TIFAC
27	Ms. Sangeeta Nagar	Scientist 'F', TIFAC
28	Dr. Yashawant Dev Panwar	Scientist 'F', TIFAC
29	Mr. Selvan T.	Scientist 'F', TIFAC
30	Ms. Mukti Prasad	Scientist 'C', TIFAC
31	Dr. Brajeshwar Chandelia	Scientist 'C', TIFAC
32	Dr. Chakradhar T.	Scientist 'C', TIFAC
33	Dr. P. K. Anil Kumar	Scientist 'C', TIFAC

II) ICT (meeting held on 4th September, 2020)

S No.	Name	Affiliation
1.	Dr. P.G. Diwakar	Scientific Secretary, ISRO
2.	Dr.Pradeep Srivastava	Executive Director, TIFAC
3.	Dr. K.K. Murali Mohan	Head, FFT Division, DST
4.	Dr. Mohan Das Pai	Chairman, Aarin Capital Partners
5.	Dr. Parminder Kakria	Head Corporate Affairs, WIPRO
6.	Dr. A.K. Garg	Head, IPR and International Cooperation, MeitY
7.	Dr. S.K. Murthy	Director of IP – Intel India
8.	Dr. Sachin Gaur	India EU ICT Standards Collaboration Coordinator
9.	Dr. Sanjeev Malhotra	CEO, IOT, Excellence Cente, NASSCOM
10.	Dr. Sheetal Chopra	India Lead – IPR Policy, Ericssion
11.	Shri Subodh Sachan	Director STPI, MeitY
12.	Dr. S. Shrotriya	Scientific Attache, Indian Embassy at Mascow
13.	Dr. Mohit Gmabir	Director, Innovation cell MHRD
14.	Dr. Vivek Mehrota	ICT Expert, Singapore
15.	Dr. Yashwant Dev Panwer	Scientist, TIFAC
16.	Shri Arghya Sardar	Scientist, TIFAC
17.	Ms. Sangeeta Nagar	Scientist, TIFAC
18.	Ms. Mukti Prasad	Scientist,TIFAC
Other Attendees 54 including TIFAC Scientists		

III) Agriculture and Food Processing (meeting held on 29th July, 2020)

S No.	Name	Affiliation
1.	Prof. Panjab Singh,	Former VC BHU and Ex Secretary DARE and DG ICAR
2.	Dr. Pradeep Srivastava,	Executive Director, TIFAC
3.	Dr. B. Venkateswarlu,	(Former Vice Chancellor, VNMKV, Parbhani, Maharashtra & Ex Director, ICAR-CRIDA, Hyderabad)
4.	Dr. Himanshu Pathak,	Director, ICAR-National Institute of Abiotic Stress Management (NIASM),
5.	Ms. MeetuKapur	Executive Director, Food and Agriculture Centre of Excellence (FACE) Confederation of Indian Industry (CII)
6.	Mr. Girish Sohani	President & Managing Trustee, BAIF Development Research Foundation, Pune
7.	Dr. S.K. Bandopadhyaya	CAU, Phasighat
8.	Dr. K.K. Singh	Scientist – G, India Meteorological Department, New Delhi
9.	Sh. Dola Shankar	IOFS, Director(Marketing), MPEDA
10.	Dr. Pradeep S Negi	Sr. Principal Scientist, CSIR-CFTRI, Mysuru
11.	Dr.Saswati Bose	DGM, APEDA
12.	Ms. Reeba Abraham	AGM, APEDA
13.	Dr. Abhijit Kar	ICAR-IARI, New Delhi
14.	Sh. V.B. Kudhachikar	BAIF, Pune
15.	Mr. Manish Whorra	CII

16.	Ms. Roli Pande	BAIF, Pune
17.	Sh. Sanjay Singh	Scientist 'G', TIFAC
18.	Sh. P. R. Basak	Scientist – F, TIFAC
19.	Dr. Gautam Goswami	Scientist – F & Head - Foresight & Vision, TIFAC
20.	Dr. Yashwant Dev Panwar	Scientist – F, TIFAC
21.	Sh. Aragya Sardar	Scientist – F, TIFAC
22.	Dr. D. Majumdar	Scientist – F, TIFAC
23.	Mrs. Nirmala Kaushik	Scientist – F, TIFAC
24.	Mrs. Sangeeta Bakshi	Scientist – F, TIFAC
25.	Mrs. Jancy Selvan	Scientist – F, TIFAC
26.	Dr. T. Chakradhar	Scientist – C, TIFAC
27.	Mrs. Mukti Prasad	Scientist – C, TIFAC

IV) Machinery and Manufacturing (meeting held on 20th August, 2020)

S No.	Name	Affiliation
1.	Dr. Pradeep Srivastava	Executive Director, TIFAC
2.	Dr. V Sumantran	Chairman, Celeries Technologies and Former Vice Chairman, Ashok Leyland
3.	Shri Anil Srivastava	Principal Consultant and Mission Director, Niti Aayog
4.	Shri Nilkanth V Marathe	Officiating Director, Automotive Research Association of India (ARAI), Pune
5.	Mr. Shushant Naik	National Head, Government Affairs, Tata Motors, Mumbai
6.	Dr. Ashvini Kumar	Former MD (SECI) and Sr. Director-TERI, New Delhi
7.	Prof. Juzer Vasi	Professor Emeritus, IIT-Bombay
8.	Prof. Chetan Singh Solanki	PI, NCPRE, IIT Bombay
9.	Dr. Satyendra Kumar	Chairman, M/s. Saurya Enertec, Gurgaon
10.	Dr R Gopalan (ARCI), Hyderabad	Regional. Director- International Advanced Research Centre for Powder Metallurgy and New Materials
11.	Dr. Rajendrakumar Sharma	Managing Director, Spel Technologies Pvt. Ltd., Pune
12.	Dr. Saptarshi Ghosh	M/s. Exide Industries, Kolkata
13.	Shri Pranjal Sharma	Economic Analyst and Author India Automated, New Delhi
14.	Sanjay Chavre, Director	Dept. of Heavy Industries, New Delhi
15.	Shri Sudhanshu Mani	Retd. General Manager, Integral Coach Factory (ICF), Indian Railways, Chennai
16.	Shri Anup Wadhwa	Director- Automation Industry Association, New Delhi
17.	Mr. Umashankar.N.Devappa	Executive Director (Defense), BEML Limited
18.	Smt. Alka Tuteja	GM & Head / Corporate Technology Management, Bharat Heavy Electricals Limited (BHEL) , New Delhi
19.	Dr. Nagahanumaiah	Director, Central Manufacturing Technology Institute, Bengaluru

20.	Prof G Saravana Kumar	Department of Engineering Design, IIT Madras
21.	Ms. Arundhati Thomas	Managing Director, M/s. Plasma Technologies Pvt. Ltd. Pune
22.	Dr. Prakash Vasudevan	Director, South India Textile Research Association (SITRA), Coimbatore
23.	Shri V K Saxena	Chairman, Khadi Village and Industries Commission (KVIC), Mumbai
24.	Shri RR Okhandiar IFS	CEO & Member Secretary, Central Silk Board, Bengaluru
25.	Dr. Subhas Naik	Director, CSTRI, Bengaluru
26.	Shri Sanjay Jayarathnavelu	MD, Lakshmi Machine Works Ltd. Coimbatore
27.	Shri Paresh Chaudhary	President, Nobletex Industries Ltd, Surat
28.	Shri N.D. Mhatre	DG (Technical), Indian Textile Accessories and Machinery Manufacturers Association, Mumbai

V) Electronics (meeting held on 4th September,2020)

S No.	Name	Affiliation
1.	Prof. Suneet Tuli	Former Dean R&D , IIT Delhi and Director, Research, Shiv Nadar University
2.	Dr. Pradeep Srivastava	Executive Director, TIFAC
3.	Dr. Sukumar Mishra	Department of Electrical Engineering, IIT, Delhi
4.	Dr. K.R. Murali Mohan	Head Frontier and Futuristic Technologies (FFT) Division, DST
5.	Shri Sanjay Nayak	CEO, Tejas Networks
6.	Dr. Prashant Kumar	Scientist 'E' MeitY
7.	Shri Parag Kar	VP, Qualcomm India
8.	Shri Shekhar Sanyal	Country Head, India Institute of Engineering and Technology
9.	Shri Pankaj Mohindroo	Chairman of the India Cellular & Electronics Association (ICEA)
10.	Dr. Rishi Mohan Bhatnagar	President, Aeris India
11.	Dr. Bharat Kale	Director General, CMET
12.	Dr. Shishir Shrotriya	Scientific Attaché, Indian Embassy at Moscow
13.	Dr. Subrata Mitra	Ericsson India
14.	Ms. Sangeeta Nagar	Scientist – F, TIFAC
15.	Shri Arghya Sardar	Scientist – F, TIFAC
16.	Dr. Yashwant Dev Panwar	Scientist – F, TIFAC
17.	Ms. Mukti Prasad	Scientist – C, TIFAC
And 46 other experts including TIFAC officials		

About TIFAC

Technology Information, Forecasting and Assessment Council (TIFAC), an autonomous organization under the Department of Science and Technology (DST) , Government of India was established in 1988. TIFAC is a think tank within government setup which looks up to technologies on the horizon, assesses the technology trajectories and supports technology innovation in select areas of national importance.

Release of TIFAC White Paper and API Report by Dr. Harsh Vardhan, Hon'ble Minister for Ministry of Science & Technology, Ministry for Health & Family Welfare and Ministry of Earth Sciences

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