MARCH 2022

VIEWPOINT

OFFICIAL QUARTERLY MAGAZINE OF CEAI

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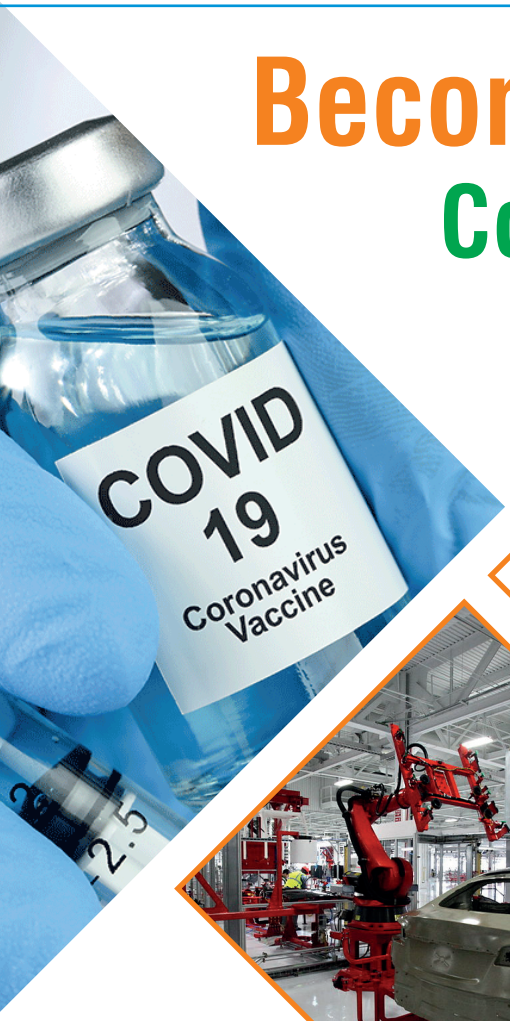
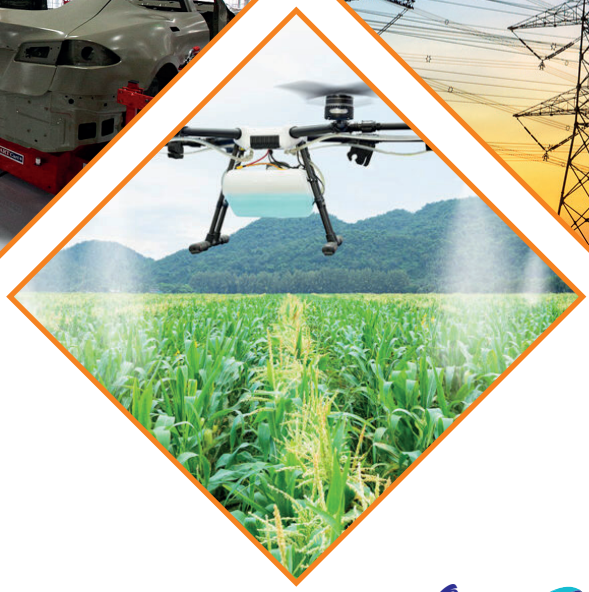
Becoming Atmanirbhar

Concept to Reality



आत्मनिर्भर भारत



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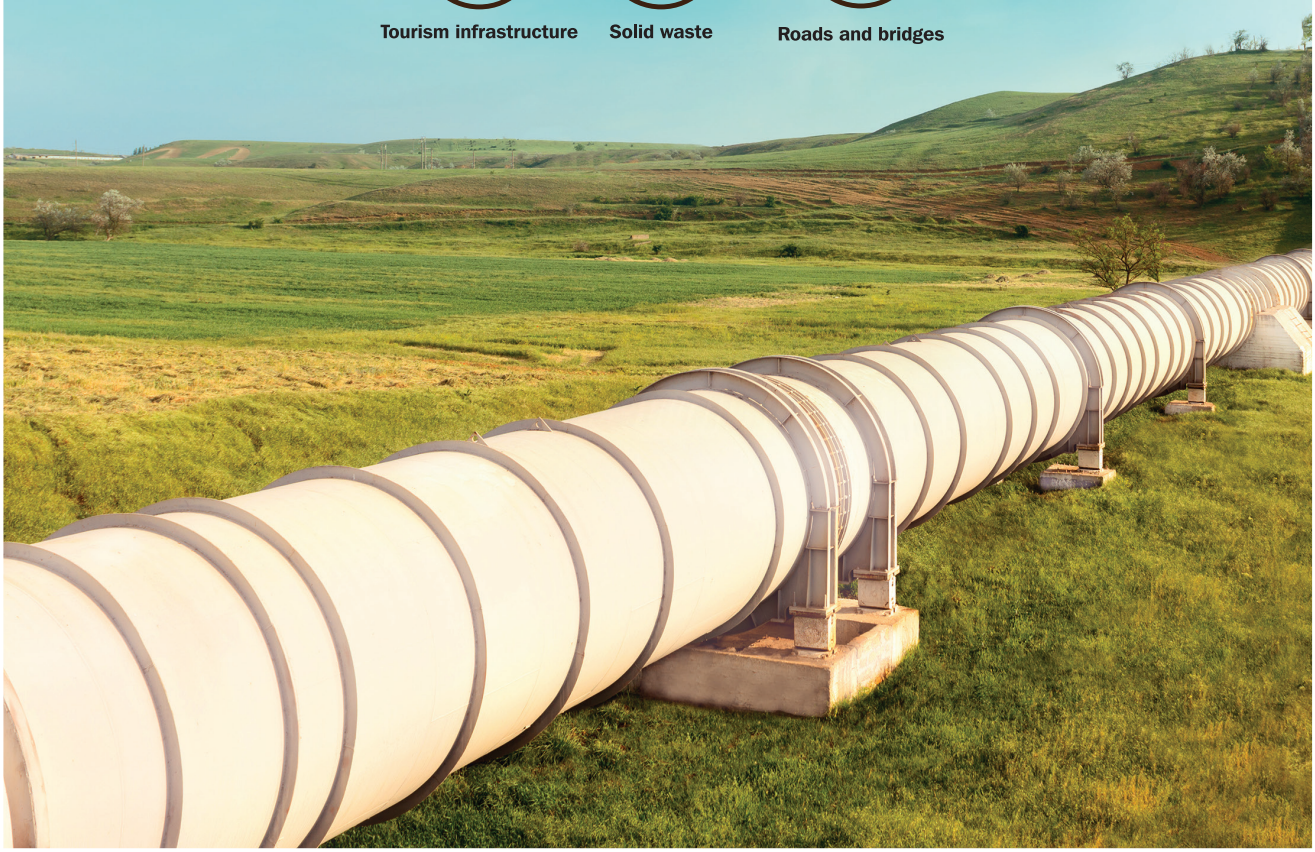

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Editorial Board Members

Message from President

Greetings to fellow Engineers, Readers, Members & Friends,

For over two years the global community has been in the fight against Corona 19 virus. During that period more than 43 million had been infected in India but some did not recover.

Friends, the virus disrupted the normal life of the world and established a new norm. Millions around the world are still facing the brunt of the pandemic; hence efforts to save precious lives still go on. No one in their life time had witnessed or imagined a crisis of such a magnitude, an enemy which new no boundaries. While the world is still trying to come out of the pandemic, it has plunged into another crisis - the war between Russia and Ukraine. That is going to add to the immense challenges that the world economy and supply chain were already facing.

Today the connotation of the term Self-Reliance has changed in the context of the global scenario. The debate on Human-Centric versus Economy-Centric Globalization is on. India's fundamental thinking provides a ray of hope to the world. The culture and tradition of India speak of Self-Reliance and the soul is Vasudhaiva Kutumbakam.

The Atmanirbhar Bharat Mission revolves around reviving all the sectors in the Indian economy - covering all aspects from demand, to manufacturing/ generating, to distribution supply, and disposal. The Make in India initiative endeavours to develop the manufacturing sector of the country - the large as well as MSMEs.

The pandemic infact, came as a blessing in disguise since it helped India strengthen its base and also be of help to other countries. India is marching ahead on the mission of Self-Reliance. It achieved providing vaccination for over 182 crores with over 83 crores fully vaccinated and that too with its vaccine; Made-in-India, has developed strong roots. Very recently India achieved a record 400 billion US Dollars of Non-Service Sector Exports. India is also making all efforts towards raising its Services sectors, including Engineering Services, to the next level as a step towards achieving the milestone of a $ 5 trillion economy.

India has planned massive investments in the infrastructure sectors including roads & highways, metros, railways, airports, ports, plus smart cities, etc together with the basic necessities such as portable tap water to over 180 million households under "Jal Jeevan Mission" – the "Nal se Jal" program, housing for all , health infrastructure with massive investments in healthcare facilities, Swach Bharat Mission, etc.

As Engineers, we need to raise the bar of our capabilities and ensure that all development and growth is better than before and sustainable so as to leave a green habited world for the future generations.

With best wishes

Dr Ajay Pradhan
President

About CEAI

Consulting Engineers Association of India (CEAI) is the apex body of consulting engineers in India having membership of organisations as well as individuals. The membership represents large, medium and small consultancy companies/ organisations both in the private and public sector and eminent individual consultants. EPC organisations are also members of CEAI since they have planning and design engineers, apart from construction management consultants.

CEAI is the Member Association, of the International Federation of Consulting Engineers, commonly known as FIDIC, the acronym for Fédération Internationale Des Ingénieurs-Conseils, representing the Consulting Engineering Fraternity in India. FIDIC has membership of more than 100 Member Association of various countries and is headquartered in Geneva.

CEAI was incorporated in 1996, with the merger of two leading national associations Association of Consulting Engineers (India) {ACE(I)}, incorporated in 1960 and National Association of Consulting Engineers {NACE}, incorporated in 1976. Thus, CEAI has, behind it six decades of accumulated knowledge and experience.

- CEAI promotes the interest and works to enhance the status of the consulting engineering profession in India
- CEAI advocates global networking and co-operation
- CEAI's activities include:
  - Quality development of Consultants.
  - Productivity enhancement.
  - Promotion of ethical practices.
  - Facilitation and interaction with government and other authorities/ bodies to streamline and improve the system of engagement of consultants.
- Regional Centres in Jaipur, Bengaluru, Kolkata and Mumbai to broad base activities.

Aims & Objectives

- Promote the professional interest and establish the rights and privileges of the status of consulting engineering profession in India
- Represent the consulting engineering profession within India and abroad. Connect the members locally and globally.
- Disseminate among the members information on all matters pertaining to engineering, especially knowledge and information related to consulting engineering profession by way of holding Conferences, Seminars, Courses, Workshops, Field/ Site Visits, etc. and thus assist in Continuing Education for the Professional Development of Members.
- Act as the principal champion for consulting engineering profession through constantly informing and educating the public and lawmakers about key engineering issues and making it possible to have the voice of the profession heard by the policy makers.
- Promote adoption of equitable forms of contracts and other documents used in consulting engineering practice.

Vision

- To represent, promote and enhance the status of consulting engineers in India as an honoured and dignified profession for nation building and propagate Indian engineering consultancy globally.

Mission

- Promote interests of the consulting engineering profession nationally and internationally.
- Promote sustainable, safe and sound engineering practices.
- Upgrade engineering knowledge and skill.
- Propagate code of professional ethics, safety, health and environment.

Values

- Commitment with tenacity to high ethical values, integrity, professionalism and achieving technical excellence and inclusive development.

Code OF Ethics

- CEAI has adopted a Code of Ethics, to which all members must abide. It is not just for the quality of the jobs they work on, but for the safety and well-being of the public at large.
- CEAI is the profession's most respected voice on the practice of ethical engineering.
- The code specifies the responsibilities of Consulting Engineers towards the society as well as the profession, to refrain from performing services unless competent to do so, to act in the legitimate interest of client, to be impartial, to maintain ethical relations with other consultants.

Message from Chief Editor

Dear Fellow Consulting Engineers & Readers,

Welcome to the first VIEWPOINT issue of 2022.

The winter is over and the knots created by the pandemic are also unravelling.

It is just a little over one year ago in February 2021, that CEAI had held a concluding event to mark the culmination of the Diamond Jubilee Celebrations of CEAI on the theme "Contribution of Consultants – Fast Tracking Atmanirbhar" The report on that was published in the March 2021 issue of ViewPoint. It will be well worth re-reading that so as to imbibe and adopt many of the suggestions and dwell on the observations made by the learned speakers plus also the message from Mr. Narendra Modi, Prime Minister and the Mr. Nitin Gadkari, Hon'ble Minister, Ministry of Road Transport & Highways and MSME.

The changes are there for all to see. The country's good exports have surpassed the US$ 400 billion mark, which the Prime Minister has called a 'key milestone' for the Atmanirbhar Bharat initiative for manufacturing self-sufficiency. He congratulated the "farmers, weavers, MSMEs, manufacturers, exporters for this success." Large investments are being made and supportive polices being enacted by the Government for all important sectors – Education, Skill Development, Roads & Highways, Transportation (road, rail, air and waterways), MSME, Power, Defence, IT & Communication, Housing, Smart Cities, etc. Let's reiterate – all those are by the Government. What needs to be uppermost in the mind of the Engineers in India, infact for any citizen, is what the one can do or train and make one self-capable and become world class so that the world unequivocally acknowledges the capabilities of Indian consulting engineering services and the engineering products in all sectors.

Time and again it has been stressed in these lines the dire necessity for integrated planning and design for, let's say, a Smart City to be truly Smart. Digitalisation has infact made integration of all disciplines of engineering easy and immediate. All concerned can work of a common model so that at all points of time everyone is fully aware of what all is incorporated into the model. CEAI has also been advising its Members and in fact all Engineers to utilize the benefits of digitalization, embrace and incorporate sustainability requirements. Climate change is a complex phenomenon but a large part has been caused by humans. Nature is supreme and that's what is manifested year in and year out. Humans are puny beings in the face of Nature. Hence, the earlier that is comprehended the better will life be in the future. In fact, that should be the first step towards Atmanirbharta. The second would then be to utilize one's own resources and be useful to others. No point in being dependent on doles; its only one who is not dependent on another can be self-confident, self-reliant and self-contained. It's

only such a one who can readily assist another. An important aspect to keep in mind especially with digitalisation being deployed in all aspects is that of ethics. Stipulating rules of conduct is a herculean task; to put it in a nut shell by ethics what each one needs to understand that the summum bonum of the society needs to be assured by any fair and just action.

Coming down to self-reliance, the current day life style, after the basics are taken care of, is dependent on Energy which is thus primary resource. Hence, ensuring that in a manner that affects the balance of Nature to the minimum would be the right source for Energy; the rest of the requirements would be easier to fulfill. Hence, many papers in this issue on "Becoming Atmanirbhar – Concept to Reality" deal with this important aspect. The views expressed by other authors are also very important and need to be addressed.

Consulting Engineers are the idea converters, the conceptualisers, the implementers, the executors and builder, and finally the operators and maintainers, hence they must strive in all that they do to add value so that what they do is better than that existing. Ultimately it is their contribution to the country's economy which makes a difference.

Engineers Must Pursue Their Profession
With A Bull Dog Tenacity Of Purpose
To Improve The Quality Of Life
In A Sustainable Manner

Happy Reading & Learning

A P Mull

Message from Guest Editor

Atamnirbharata. and Engineering Services

Atamnirbharata in the simple dictionary meaning is Self-Reliance, in every dimension. Sometimes it is misunderstood to cutting-off from import and collaborations, however, the practical professional interpretation is local. Atamnirbharata is to meet all possible requirements through local manufacturing and services and promote exports to the maximum. Ultimately economic and social development should be through local efforts. The debates will continue but policy push and entrepreneurial skills will carry the country to Self-Reliance. Engineering services play a crucial role in attaining this Self-Reliance while moving to a $ 5 trillion economy by 2025.

Government of India has identified that infrastructure goals should be fulfilled and efforts are afoot towards that through the PPP model. The goals include: affordable and clean energy, digital services access for all, convenient and efficient transportation and logistics, housing and water supply, quality engineering education, good health and well-being, sustainable and smart cities, disaster resilience, and leveraging technology for public good. The National Infrastructure Pipeline has created a positive impact, and it has served well even during the Corona-19 pandemic. Capacity utilisation is expected to catch up resulting in an improvement in the investment cycle.

The Consulting Engineers Association of India is an appropriate platform to provide expertise to multiple industries and start-ups that need cutting edge technologies and outstanding and effective practices. Some of the large companies can develop this capability in time but all cannot develop in a short time. Engineering Consultants can provide the knowledge and expertise to attain the goals faster. This issue reflects the experiences and views of experts for users to learn.

I am grateful to CEAI to associate me with this effort.

Pradeep Chaturvedi
Chairman, Emerging Technologies Task Force
The Institution of Engineers (India)

The Theme is Build Back Wiser – Engineering the Future.

A World Engineering Day Hackathon was held to encourage engineering students to work in teams towards a global real-world problem.

The competition was a fast-paced simulation of a real-world project. Teams were to work collaboratively on a problem to provide a set of deliverables within a short timeframe. Utilising their theoretical knowledge, students could gain first-hand experience to develop their critical thinking, build new skill sets, push themselves out of their comfort zone and build lasting relationships.

World Engineering Day (WED) for Sustainable Development is celebrated on the 4th of March every year as a **UNESCO** international day promoting the profile of engineers and engineering. WED is an opportunity to engage with governments, organizations, universities, industries, media and the community to address the need for engineers around the world to develop strategic frameworks and best practices for the implementation of engineering solutions for Sustainable Development.

In 2022, The World Federation of Engineering Organisations **(WFEO)** and its members and partners hosted the HACKATHON, an international event with a goal to involve engineering students from all over the globe in the celebration of the World Engineering Day.

To view the wining entries go to

https://worldengineeringday.net/hackathon/#:~:text=Aligned%20with%20a%202022%20Theme,a%20global%20real%2Dworld%20problem

01

Atmanirbhar Bharat Abhiyaan and its impact on Micro, Small and Medium Enterprises

Dr. Om Parkash Mehta
Director (IEDS)
Office of the Development Commissioner (MSME)
Ministry of Micro, Small & Medium Enterprises (MSME)
Government of India

Vision of Atmanirbhar or Self-reliant India

With the aim to make the country and its citizens independent and self-reliant in all respects, the Hon'ble Prime Minister (PM) Shri Narendra Modi gave a clarion call to the nation on 12th May 2020 and kick started the Atmanirbhar Bharat Abhiyaan (Self-reliant India campaign), a vision of new India and announced a Special Economic and Comprehensive package of INR 20 lakh crores - equivalent to 10% of India's GDP – to fight the COVID-19 pandemic in India. The package caters to various sections including Cottage Industry, MSMEs, Corporate, Enterprises & Industries, Health sector, Agriculture sector, Poverty Alleviation, Labourers, Middle Class, among others. The Five Pillars of Aatmanirbhar Bharat outlined are:

1. Economy (Goal to make India a USD 5 Trillion economy by 2025),
2. Infrastructure (more than INR 100 lakh crore in infrastructure development),
3. System (based on 21st century technology-driven arrangements),
4. Vibrant Demography (will prove a competitive advantage), and
5. Demand (utilised to full capacity).

Ministry of Micro, Small and Medium Enterprises (MSME), Government of India and action taken on Atmanirbhar Bharat Abhiyaan or Self-reliant India

MSMEs are the Engines of growth for the Indian economy. The Ministry of MSME's vision is sustainable development of globally competitive Micro, Small and Medium Enterprises (MSMEs). MSMEs currently contribute about 30% of GDP. The Ministry promotes and develops MSMEs through various initiatives which include:

- New Enterprise Development & Employment Generation
- Credit Assistance
- Technology Upgradation
- Infrastructure & Capacity Building
- Procurement & Marketing Support
- Skill Development & Entrepreneurship Development training
- Implements schemes for Khadi, Village & Coir Industries

During the Covid pandemic and lockdown, various organisations under the Ministry contributed by ramping up the supply of resources and facilities across the states and production of Medical disposables like PPE Kits, Ventilators, Oxygen concentrators, Hand sanitizers, Masks, preparation of Detailed Project Reports (DPRs) especially for reducing import of items reserved for exclusive procurement from MSEs, eBooks and other publications, etc. to combat the

pandemic. Subsequent to the various **Atmanirbhar Bharat Abhiyaan** announcements the Ministry swung into action and brought a number of initiatives in order to facilitate the working, promotion, growth and development of MSMEs across the country. All these initiatives inter alia with the existing programmes are digitally available on the websites of the Ministry (www.msme.gov.in) and its apex organisation – the Office of the Development Commissioner (MSME), an attached office to the Ministry, (www.dcmsme.gov.in). Some of the major initiatives are:

1) ₹ 20,000 crores Subordinate Debt for Stressed MSMEs was launched on 24th June, 2020 to provide credit facility to promoters of stressed MSMEs.
2) Setting up of a Fund of Funds [Self Reliant India (SRI) Fund] with a corpus of ₹ 10,000 crores to provide equity funding support of ₹ 50,000 crores for MSMEs.
3) Implementation of revised Definition of MSMEs was made applicable from 1st July 2020 with dual criteria of turnover and investment in plant and machinery. Under the revised definition the export of goods or services or both shall be excluded while calculating the turnover thus giving recognition to exports of MSME in the country and serve as a boosting measure. Retail and Wholesale trades have been included from 2nd July 2021 and the Street Vendors can register as Retail Trades from 9th August 2021.
4) Global tender for procurement upto ₹ 200 crores has been disallowed for Government procurement. Necessary amendments have been made in the General Financial Rules (GFR).
5) Udyam Registration Portal (New process of MSME Registration: Ease of Registration) was launched on 1st July 2020. The earlier Udyog Aadhaar Memorandum (UAM) has been replaced by Udyam Registration.
6) An online Portal "Champions" (https://champions.gov.in/) which was launched on 1st June 2020 by Hon'ble PM covers many aspects of e-governance and e-promotion of MSMEs.
7) Other interventions for MSMEs such as E-market linkage for MSMEs to be promoted to act as a replacement for trade fairs and exhibitions; MSMEmart Portal – NSIC; ekhadiindia Portal – KVIC; Procurement and Marketing Support Scheme.
8) MSME Receivables: Dues of ₹ 76,920.28 crores have been paid to the MSEs vendors by Government Ministries/ Departments/ Central Public Sector Undertakings (CPSUs) from May 2020 till 17th November 2021. A special sub-portal within the SAMADHAAN portal (https://samadhaan.msme.gov.in/), an online reporting system, has been developed for reporting the dues and monthly payments by GOI Ministries and CPSEs to the MSEs, was launched on 14th June, 2020.
9) Trade Receivable e-Discounting System (TReDS) Platform: TReDS is an electronic platform for facilitating the discounting of trade receivables of MSMEs through multiple financiers. MSMEs have been exempted from paying on-boarding charges on TReDS platform till 31st March, 2021.
10) Various Publications: DCMSME under the Ministry has brought out a number of publications (available on the website http://dcmsme.gov.in/) for MSMEs which include eBook on Schemes for MSMEs, Breaking the Silos List of Facilities & Projects (State/ UT wise), Testing and Calibration Facilities available at MSME Testing Centres & Testing Stations, E- Book on the Activities of MSME Technology Centres and its Extension Centres, Benefits of taking Udyam Registration, Aatmanirbhar Presentation Series, Project Profiles for Small Enterprises, Detailed Project Reports on Import Substitution for various products, Laghu Udyog Samachar MSME April 2020 to October-2020 and Udyam Registration Bulletin – I to VI, etc.

Atmanirbhar Bharat Abhiyan, Budget Announcements (FY 2022-23) and MSME Sector

Although the pandemic has made achieving the targets of making India a USD 5 trillion economy and a global

power house by 2024-25 more challenging hence to achieve that requires increased development work in all its spheres including MSMEs. Former Reserve Bank Governor Mr. C. Rangarajan, India cautions that becoming a USD 5 trillion economy by 2025 is impossible under the current circumstance of Covid pandemic, for that the country needs to grow at 9 per cent per annum for the next five years in order to achieve that target.

The Union Minister for Finance and Corporate Affairs, Smt. Nirmala Sitharaman, while presenting the Union Budget (2022-23) on 1st February 2022 in the Parliament, stated that India's economic growth in the current year is estimated to be 9.2 per cent, highest amongst all the large economies. The overall, sharp rebound and recovery of the economy from the adverse effects of the pandemic is reflective of the country's strong resilience. Figure-1 depicts the Budget at a Glance.

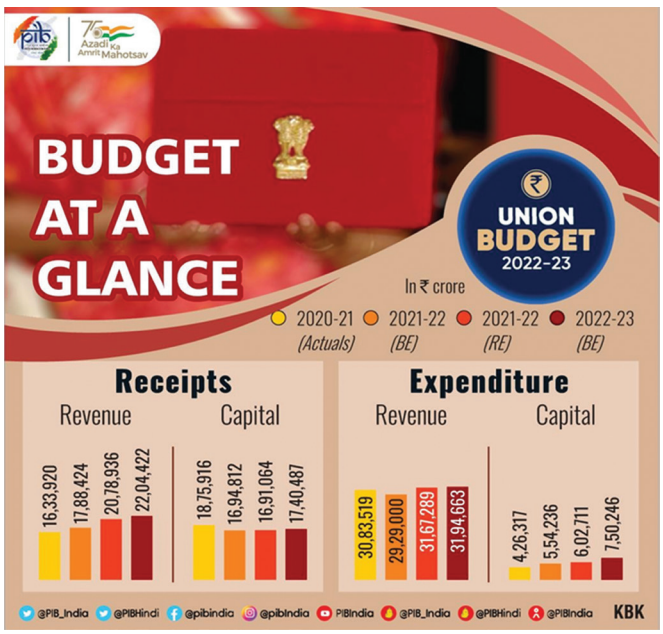

Figure-1: Union Budget 2022-23 at a Glance

The Union Budget 2022-23 unveils the PM GatiShakti Master Plan (National Master Plan for creating World Class Modern Infrastructure) which is a clear indication of increased effort by the government to create capital assets of the country that have a long-lasting impact on technological upgradation and growth and development of economic activities in the country. The plan is depicted in Figure-2.

Figure-2: PM GatiShakti Master Plan (National Master Plan for creating World Class Modern Infrastructure)

Budget Announcements of the Minstry of MSME

Government of India allocated Rs. 21,422 crores in the budget (BE) for the Financial Year (FY) 2022-23 to the Ministry of Micro, Small and Medium Enterprises (MSME). That comprises a major portion amounting to Rs. 15,000 crores for Guarantee Emergency Credit Line (GECL) facility to eligible MSME borrowers, and is being implemented through the MSME Ministry. The budget announcements of FY 2022-23 include a number of initiatives for MSME as shown in Figure-3.

Emergency Credit Line Guarantee Scheme (ECLGS) has provided the much-needed additional credit to more than 130 lakh MSMEs to help them mitigate the adverse impact of the pandemic. Hospitality and related services, especially those by micro and small enterprises have now been added under the scheme. The ECLGS will be extended up to March 2023. Its guarantee cover will be

expanded by Rs 50,000 crore to increase the total cover of Rs 5 lakh crore, with the additional amount being earmarked exclusively for the hospitality and related enterprises.

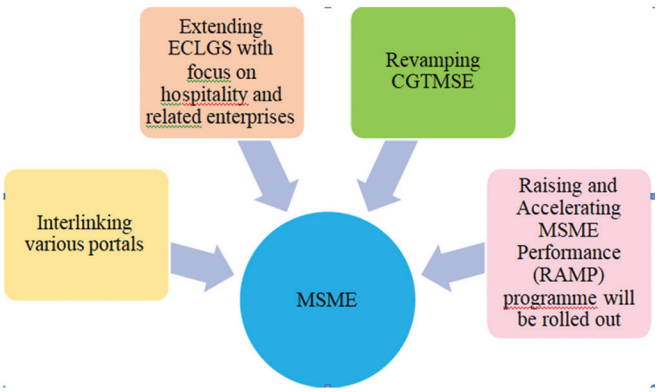

Figure-3: MSME Support in Budget 2022-23

Similarly, the Credit Guarantee Trust for Micro and Small Enterprises (CGTMSE) scheme will be revamped along with the required infusion of funds. That will facilitate an additional credit of Rs 2 lakh crore for the Micro and Small Enterprises and expand employment opportunities. The Finance Minister also informed that a Raising and Accelerating MSME Performance (RAMP) programme with an outlay of Rs 6,000 crore over 5 years will be rolled out to make the MSME sector more resilient, competitive and efficient. Udyam, e-Shram, NCS and ASEEM portals will be interlinked and their scope will be widened.

Conclusion

With the support to the MSME sector as outlined above, the sector is poised to contribute to the recovery of the economy in various sectors, directly and indirectly, while facing the challenges on account of the covid pandemic requiring much needed rapid changes and enhancements in technology towards the goal of Atmanirbhar Bharat inter alia achieving the goal of a USD 5 Tn economy.

IBEF
INDIA BRAND EQUITY FOUNDATION
www.ibef.org

60 mn rural households got tap water since Jal Jeevan Mission launch: Govt

IBEF: March 23, 2022

Since the commencement of the Jal Jeevan Mission, an extra six crore rural families have received tap water connections, according to Minister of State for Food Processing Industries and Jal Shakti of India Mr. Prahlad Patel. Water conservation, according to him, is a top concern for the government to ensure that future generations are not harmed. Until now, a total of 9,24,88,379 rural houses have been connected to a public water supply.

He further emphasised the need of groundwater conservation and how it is a pressing requirement. NMCG Director General Mr. Asok Kumar said India is the largest exploiter of groundwater. He said, “We are exploiting 250 billion litres of groundwater stored by our forefathers. If we keep on with this exploitation, then the water table will keep going down, and in 25 years, we will have scarcity of drinking water.”

02

Atmanirbharta in Engineering Consultancy - The Way Beyond

Amitabha Ghoshal
Immediate Past President
Consulting Engineers Association of India

Abstract

The Indian Engineering Consultancy profession was compelled to practice self-reliance immediately after the country won independence. At that time India had very little export earnings, except through the sale of tea and jute, and that too at prices fixed by the monopoly buyers from the erstwhile ruler country.

The meagre foreign exchange balance did not permit sanction of non-essential spendings - and infrastructure development and consultancy featured in that category. India had very little funds left for development works during the initial stages anyway.

It was only during the second Five-Year Plan, commencing in the late fifties, that emphasis was laid on industrial developments, starting with Steel manufacturing and Electrical Power generation. The first major initiatives in the consultancy sector started with the formation of M N Dastur and Company in the steel sector, and by Tata Ebasco and the Indian office of Kuljian Corporation in the power sector. Even prior to that, talented individuals like Ramanlal Mahimtura, Mahendra Raj, R L Nene, Shirish Patel, et al and Indian partners of firms like Ballardie, Thompson, and Mathews of Calcutta, initiated the consultancy practice in the Building sector. Indian firms like STUP, CES, and ICT started operations to address demands in specialized growth areas. With the demand rising, more and more individuals started consultancy services in various sectors, and the consultancy practice took firm root in India. With limited investments in new growth, the local consultants managed to meet the needs of the country fairly well, importing technology from abroad whenever the needs arose.

The situation started changing when the Government of India decided to accept loans from multinational banks, which provided for the employment of vendors internationally, and on QCBS (Quality and Cost Based Selection) basis. International consultants scored higher in technical marking, based on their exposure in multiple countries and due to the wider experience of the specialists fielded by them.

Accelerated growth in the infrastructure sector with funding by the multinational banks, prompted the induction of a large number of homegrown consulting organisations, but they lacked experience and trained manpower. Thus, the quality of deliverables deteriorated and integrity issues cropped up, bringing disrepute to the Indian consultancy sector.

The arrival of new technology and digitalisation globally has also thrown up challenges in the sector.

Whilst the larger Indian consulting engineering organisations are coping with the situation, it is the smaller ones and the individual consultants who need

hand-holding. The time has, therefore come, for the government to support and encourage the consultancy sector.

The Government needs to support them to maintain their Atmanirbhar status by reserving the advantages of MSME sector for the consultancy organisations that have a majority ownership by Indian nationals. Government support is also required for helping the Consultancy sector to export Indian expertise. For the latter, the government has responded by including the Consultancy sector as a thrust area for the Service Export Promotion Council (SEPC) under the Ministry of Commerce, Government of India. To achieve that aim, it is necessary to increase the professional knowledge and skills of the Consultants. Consultancy firms also need to be oriented towards the export of services.

CEAI has been endeavouring to do that – to skill young engineers and make them capable of meeting the challenges of executing projects abroad. India has the advantage of having a large number of technical manpower, who are proficient in the English language, and the country should reap the benefits from the same.

With the increased export of Indian consultancy services, this sector can go beyond the Atmanirbhar status that they had been enjoying within the country, and become leaders in the international arena.

A. Preface

Engineering Consultancy took off in India on a reasonable scale only about sixty years ago. Immediately after getting liberated from foreign domination, India faced a shortage of foreign exchange, with limited export opportunity – primarily in the tea and jute sectors, and that too with the prices dictated by the monopoly purchasers. The critical foreign exchange situation compelled Indian industries to become self-reliant and make do with the available resources. Initially, there was very little development potential but matters started improving with the launching of the second Five-Year Plan when the emphasis was laid on the creation of new steel industries as well as generation of electrical power.

Initially it was talented and enterprising individuals, who started practicing as consultants in chosen areas, often helping out individuals and small construction firms or developers, that took up Engineering, Procurement and Construction (EPC) assignments.

Consultancy firms, steer-headed by Indians, were formed and one could find firms like The Kuljian Corporation of USA, (later became Development Consultants, with Indian staff ownership), M N Dastur & Co., and Tata Ebasco Consulting Engineering Services facing the challenges of the new demands. In other infrastructure areas, new units came up like STUP consultants closely followed by CES India, ICT, Span, LASA, and others. In the area of buildings and other structures persons like Ramanlal Mahimtura, Mahendra Raj, R L Nene, Shirish Patel, et al and successors of old British-owned firms like Ballardie, Thompson and Mathews established themselves well.

B. Successful Beginnings

The spirit of the development of Indian Consultants can be best understood by studying the development of three organisations, named earlier. M. N. Dastur & Company (P) Ltd. (DASTUR), the first truly Indian-owned consulting firm that won international acclaim. Minu Nariman Dastur, the founder of Dastur, worked with the Tata Iron & Steel Company (TISCO, now TATA Steel) for a few years after his graduation and then went to study at Massachusetts Institute of Technology (MIT), USA, with a scholarship from the TATA house. After obtaining his PhD. he continued to work for US companies and gained insight into the steel industry and started working in other countries on behalf of the US company. While on an assignment in India for expansion of the Mysore Iron and Steelworks, he was invited by the then Prime Minister Jawaharlal Nehru to come back to India and set up a firm for serving the Steel industry. He did that and started DASTUR at Kolkata. His vision was to have an organisation with competent Indian engineers who are familiar with Indian conditions. Dasturco succeeded in setting up the Ferro-Manganese plant for the Tata group and then helped the Tata steel plant to grow from a One-million-

ton capacity to a Ten-million-ton plant with no external investments. DASTUR set up the first integrated steel plant in Libya including all the related infrastructure like Port, road network, water supply, etc. Dastur also worked in countries like Venezuela, Egypt, Malaysia, Canada, Qatar, Bangladesh with global recognition for quality service. They set an example for other aspiring consultants that Indian talent can make India Atmanirbhar in consultancy and also export services across the globe.

Another example is that of Tata Ebasco Consulting Engineering Services, a collaboration between Tata Electric Companies and Ebasco of USA, when the Unit 3 of the Trombay Thermal Power Plant, was to be set up with American Aid near Bombay (now Mumbai). It later became Tata Consulting Engineers, a wholly Indian company. Starting with Power, it diversified over the years into many other areas – Chemicals, Petrochemicals & Fertilisers, Industrial, Nuclear Power, Special Projects, Water & Waste Water, Buildings & Urban Planning, Environment & Ecology, Airports, Ports & Harbours, Steel & Mining, Construction Management, Project Management, et al, with offices in other cities as well. TCE also started overseas ventures and has executed projects across 55 countries. It has received many awards for its excellence in engineering. It is the first among the engineering consultants to get in 1994, the ISO 9001:1994 EN ISO 9001:1994 and IS 14001:1994 accreditation. TCE always attaches great importance to the development of human resources and adopting the latest proven technologies - it had begun its digitalisation process in the late 1970s.

The third example is that of Development Consultants set up by Dr. Sadhan C. Dutt, a young engineer, who launched the Indian operations of The Kuljian Corporation (TKC) of USA, a pioneering stand-alone consulting engineering firm in India. It coincided with the post-independence quest for an industrial future of the country. It later became Development Consultants Pvt. Ltd. (DCPL) and has been engineering projects in the fields of Power Generation, Transmission & Distribution, Cement & Mining, Chemicals & Petrochemicals, Mineral Processing & Beneficiation, Pulp & Paper, Material Handling, Architecture, Environment, etc. in India and in 60 countries around the globe.

The government sector was a leader in development spending and started feeling the crunch for the shortage of local Engineering capability and hence they started the development of consultancy units sectionally. They were Metallurgical & Engineering Consultants (India) Limited (MECON) in the Steel sector, Projects & Development India Limited (PDIL) in the Fertilizer sector, Engineers India Limited (EIL) in the Port, Oil and Gas sector, Central Mine Planning & Design Institute Limited (CMPDI) in the Coal sector, Water and Power Consultancy Services (India) (WAPCOS) in the Water Resources, Power and Infrastructure sector, and Rail India Technical and Economic Service Limited (RITES) in the Railway sector. Engineering capability increased as India moved forward with homegrown engineering talent and Engineering Consultancy found its place in the country as a distinct sector on account of the spurt of development within, and further boost that came with the remarkable growth in demand from the Oil-rich Middle East countries. Indian consultants often sought support from abroad in specific cases and technology transfer helped boost local capability.

Foreign funding agencies like the Asian Development Bank (ADB), The World Bank, the Department of International Development (UK), (DFID), and the Japan International Cooperation Agency (JICA), et al which were invited to invest in India, brought in a new culture for the selection of Consultants – the Quality Based Selection (QBS) process. The role for consultants got enhanced with responsibilities for supervision and project management. Responsibility for certifying measurement books and approving variation and claims were transferred to the consultant's team. The role of government authorities became that of the owners of assets and Consultants had to take up the role of a Consulting Engineer in the true and complete sense to provide end to end services.

That model was replicated by new autonomous agencies like the National Highways Authority of India (NHAI)

which was launched for meeting the challenges of rapid urbanisation and was entrusted with faster growth of National Highways network across the country and integrated urban development projects.

The national policy for improvement of Infrastructure for achieving rapid growth of the economy helped the Engineering Consultancy profession to grow rapidly. The changed system of procurement of Consultancy service introduced transparency and freed the sector from the regime of Least Cost-based selection process.

Following the example of bodies like NHAI, QBS and Quality cum Cost Based Selection (QCBS) processes became widespread methods for appointment of Consultants and thus the client profile grew larger with even Municipalities and Panchayats opting to have capable consultants to expedite project implementation.

Engineering Consultancy profession became financially attractive and Consultants rapidly enlarged their field of activity by attracting trained manpower from different disciplines.

FIDIC based contracts as required by the multilateral funding agencies became more popular and Construction agencies benefited from the unbiased decision-making by Consultants performing as The Engineer.

Striving for Atmanirbharta, Indian Consultants succeeded in closing the gap in quality of submission vis-à-vis those from Developed countries. The Export of Consultancy services to Asian and African countries also grew steadily, bringing in economic benefits for the consultants and the country.

C. Problems which Lead To Decline of the Sector

With accelerated growth in Consultancy assignments and widening of the client base, certain problems have started surfacing, and these need to be addressed by the Consultancy fraternity in a collective way.

Problems in the Selection Process

With accelerated growth in Consultancy assignments and widening of the client base, certain problems have started surfacing and these need to be addressed by the Consultancy fraternity in a collective way.

The new system of appointment of consultants was not fully assimilated by many authorities, particularly those who had not been appointing Consultants on a regular basis.

Some of the documents prepared for the appointment of a consultant lack in logic and often include qualifying clauses that are impossible to meet by the Indian consultants. For example, for the design of a four-lane highway, experts with experience of a six-lane highway and with concrete pavement are called for, when it is well known that such a road had not been built in the country. It therefore appears that documents are prepared so that no Indian consultant can qualify, or may be only one consultant can qualify.

Again, many times the weightage of various requirements are not defined in the bid document, leaving the scope for manipulation by giving higher weightage to attributes that may suit a pre-identified party.

Decline of Service Quality

Taking advantage of the sudden growth in demand, there has been a proliferation of Consultancy firms with little commitment to professional accountability and responsibility. Consultancy firms are set up by Individuals with a pure profit motive, and they book business by producing inaccurate job data sheets and CVs. Such consultants, without professional integrity, produce poor quality that affects project delivery. That practice has also tarnished the image of Indian Consultants considerably and is also destroying the Atmanirbhar status that the sector had earned.

Threat from Abroad

With recession setting in much of the developed industrial world, there has been a rush of International consultants coming into the country. Many of them have set up offices in the country, appointed local personnel and started bidding by claiming the past experience of

the organisation abroad as their qualifying document. However, when awarded, they carry out the job with largely untrained local personnel, using the names of some foreign experts as the Team member. Many of such Consultants, who are eager to develop long term business in India, influence the authorities by citing their past International experience, which may not always be factual. Unfortunately, the deep-seated respect of many Indians, for "foreign" knowledge and experience often blind the authorities and they get preferential treatment. With no restraint on award of jobs to such foreign owned Indian units, the share of jobs to Indian owned consultants are on the decline, which results in stymying and even stagnation of the development of local expertise.

Changes in Working Conditions & Accounting Operations

Of late, there have been changes in the contract conditions that are affecting the working of the consultants. Some of them have come in place because of the unfair practice adopted by the new generation of profit-oriented short-sighted Consultants, but it is equally hurting the established professionally oriented consultants.

Some of these are:

GST (Goods and Service Tax)

If an association of consultants work for a project that is exempted from Service Tax, it's only the lead firm that is given exemption from tax payment. The associate firms are not allowed exemption and they have no way of getting refund of such taxes payable under extant interpretation of Service Tax Rules.

Cash Flow concerns

Poor cash flow situation is being imposed on consultants by employer agencies, who are asking for multiple protections like Performance Guarantee (10%), deduction towards Security Deposit (5 or 10%), Professional Indemnity Insurance covering the entire cost of the project, and not just the consultants' fees. In addition, the payment schedule provides for withholding of a substantial part of fees to be paid progressively with construction on the site (field), over which the consultant has no control and that is a very lengthy process.

Delays in Release of Payments

Certification of invoices and release of payments to consultants are getting inordinately delayed due to contradictions in contract conditions and with very little or no accountability for those responsible for giving approvals at different stages, checking, approving and making payments in a time bound manner. The problem got aggravated due to communication issues during the Pandemic. While this issue is being pursued by CEAI, the problem is still persisting.

The consultants today are heavily burdened with negative cash flow, which is forcing them to survive on overdrafts from the bank, which again carry a high rate of interest, and are being sucked into a Debt Trap.

The Bank Guarantee eligibility of most Consultants are exhausted, forcing them to pledge whatever assets they have, thereby reducing their entitlement for overdrafts.

Engineering Consultants today are forced to worry more about financial issues rather than putting their energy and brainpower on engineering matters.

The litany of woes goes on. The fact remains that there is a real threat of extinction of the Indian Consultancy sector, ready to be replaced by MNC Consultants who have much greater money power. Ultimately that could lead to Intellectual Colonisation in the engineering sector, where Indian professionals had reached world standard by their dint of perseverance and sincere efforts for excellence and in many cases, they have engineered unique designs.

D. Way Forward To Future Perfect

If is high time that the various stakeholder Ministries, Public Sector Units, Local Bodies, etc. find ways and means to resolve the issues by discussing with the apex body of Consultants like the CEAI and initiate collective emergency action to restore the Consultancy profession back to the Atmanirbhar status. There is

scope to upgrade the Consultancy profession into a sustainable industry by:

- Concerted approach from the Consultancy profession and Government agencies to develop fair and effective contract documents that take note of the weak financial status of Indian consultants.
- Assess the future trend for Consultancy services with the development of the Digital revolution all over the world, and decide how to arm the Indian Consultants, especially those in the MSME categories, to join the stream and perform to world-class quality.
- Jointly with the Government, develop a program for strengthening of Consulting Organisations. The Government can help by recognising such training schemes as an essential attribute for valuing the consultancy professionals.
- Indian Consultants to orient themselves albeit with support from the Government towards export of services, in areas and sectors where opportunities exist or could be evolved.

Contractual matters

On this first item, work is already in hand, starting with the Transport sector, to make the contract documents user-friendly and cater to the needs of the Consultants for sustainable growth. The same effort needs to be carried forward to all other sectors and in this matter, CEAI would have to take the lead in a coordinated manner by forming a task force from the members of the profession.

Strong measures will have to be initiated to ensure professional integrity and strict control exercised to guarantee Quality.

Future trend of Consultancy services in the Digital era and the new demands of society

New technological developments are being announced every other day. AI, Data Analytics, IOT, VR, AR, Metaverse etc. are becoming part of the lexicon and need to be assimilated and utilised for the challenges thrown up by the demands for a sustainable future for humanity and in fact all living beings. For sustainability to become a reality and overcome climate change matters, it will be necessary to embrace new technologies that can radically reduce consumption of non-renewable resources, use more renewable and recycled manufactured materials and energy, and attempt zero carbon developments progressively. Orienting Indian consultants in these new directions will need systematic training and skilling of manpower.

Strengthening of the Consultancy sector

For achieving this task, Engineering associations and organisations like IEI, CEAI, ECI, Chambers of Industry/ Commerce will have to work in tandem with Government support. Structured courses will have to be developed for training of staff as also for the senior decision makers. Employers will have to permit and encourage personnel to get trained in these areas to make them effective in the new environment and for handling the new challenges. Such training will be necessary for personnel in construction organisations and manufacturing industry, as also those in government bodies controlling the performance and growth of the engineering sector.

Export of Consultancy Services

India is foremost amongst the countries that have come out of colonial rules and have made progress in all sectors, with Atmanirbharta, becoming the fifth largest economy in the world. India is also looking to become a USD 5 trillion economy in the near future. India progressed and grew by adopting technology that is appropriate and affordable for a developing economy. Indian technology is suited for the other developing economies of the world and that has allowed India to become an exporter of Consultancy services to many of the developing countries in Asia, Africa, and South America, mostly based on an individual effort by enterprising Consultants working in India.

Now it is more important to take the Indian consultants to the world stage in an organised manner so that Indian consultants become active participants in the forthcoming developments across the world, starting

with all the developing countries that need the application of appropriate technology suited to their country's requirement.

By exporting Engineering Consultancy Services, the Indian consultants would gain financially and also develop a broader outlook. More importantly, working abroad gives the professionals a greater sense of confidence and satisfaction, which translates into the qualitative growth of the organization. The country also gains a better image and acceptance globally.

Training course and guidance documents need to be prepared for hand holding the consultants who are ready to venture into the export of Services.

Conclusions

The Government has already declared engineering services as a thrust area for export of services and that is being promoted by the Ministry of Commerce through the Service Export Promotion Council (SEPC). By joint efforts of CEAI and similar bodies together with the Government machinery, it would be possible to make Indian Consulting Engineering a sought-after value-added Service across the globe.

With combined efforts by Public-Private partners, it will be eminently possible to make the Consulting Engineering sector the pride of Atmanirbharta and more, since, for all development and growth, science and engineering are a Must.

Design Taxi

Solar Panels Made From Waste Crops Don't Need Direct Sunlight To Produce Energy

By Ell Ko, 23 Feb 2022

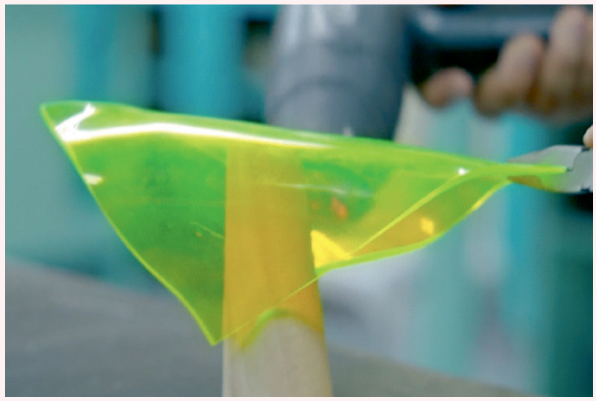

Image via the James Dyson Foundation

Solar panels work with light—it's in the name. They're a cleaner source of energy and harness something nature provides us. But because they rely on a supply of direct sunlight, they might not be viable for everyone, especially those who live in cold places with less natural light.

'AuREUS' is a new type of solar panel created by Carvey Ehren Maigue, a student at the Mapúa University in the Philippines. The idea was to create panels that, instead of using direct sunlight, are powered by the ultraviolet rays of the Sun, which clouds don't block.

Source: https://designtaxi.com/news/417859/Solar-Panels-Made-From-Waste-Crops-Don-t-Need-Direct-Sunlight-To-Produce-Energy/

03

Self-Reliance: A Management Perspective

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Abstract

At times, the usage of the terms dependence, independence and interdependence create confusion. In that context, the question arises: Is it possible to find a place for Self-Dependence or Self-Reliance in the highly interconnected world? Are those terms just buzzwords or do they carry distinct and practical meanings? The paper contextualises Self-Dependence in an engineering consulting organisational set up, through a wider perspective of philosophy, psychology and modern organisational management theories. The paper discusses underpinning of Self-Dependence to provide a theoretical base to its adaption in the organisational set up. The meaning of 'Self-Dependence' is a highly contextual one and hence the paper provides different perspectives to help one arrive at one's own understanding of the terms.

Introduction

To provide a boost to the country's economy and also to lift the morale and pride of the people, India announced the 'Atma-Nirbhar Abhiyan', a policy of Self-Reliance which rests upon the five pillars of Economy, Infrastructure, Systems, Demography and Demand. The policy announcement and the subsequent references of the same brought the 'Atma-Nirbhar' and 'Atma-Nirbharta' terminologies into prominence and it quickly became a part of the common lexicon. The engineering community plays a vital role in the varied aspects of the development and growth of the country, right from conceptualisation to implementation of policies and later maintaining of what has been built. Hence, there is a need to have the correct contextual perspective and understanding of these terms for engineering professionals.

The concept of Self-Reliance is not new; it is as old as mankind. Even primitive human beings always sought to make living, as independent of other factors to the extent feasible. In the march of civilization, mankind has come a long way since the times of the primitive men. Ancient Indian texts also preach it. In modern times, the essay titled 'Self-Reliance' written in 1841 by American philosopher Ralph Waldo Emerson is widely referred to. The term 'Self-Reliance' finds mention in different languages and has been elaborated to a great extent in many cultures and societies. However, for this paper the discussion is founded on the thoughts and theories of more recent times.

The paper is structured around three sections. The first section discusses various versions of terminologies and definitions of Self-Reliance. The second section provides a perspective through modern management theories like the Social Exchange Theory (SET), Core Competence Theory (CCT), Resource Based View (RBV) and Knowledge Based View (KBV). The third and last section provides the conclusions.

Various Interpretations of Self-Reliance or Self-Dependence

Throughout the history of mankind, the topic of Self-Reliance has been dabbled by great many intellectuals, scholars, artists and statesmen. The Indian, Chinese, Arabic, Greek, Roman, Japanese, Europeans and countless other societies have discussed and provided their own interpretation while highlighting the importance of the term. Napoleon Bonaparte advocated that '*if you want a thing done well, do it yourself*' whereas Rev. William J. H. Boetcker, said, '*you cannot help people permanently by doing for them, what they could and should do for themselves*.'

Almost every matured language is peppered by tribal knowledge about Self-Reliance in the form of common sayings. One of the most commonly found saying is '*One who depends upon others is sure to be ultimate failure*'.

Merriam-Webster defines Self-Reliance as 'reliance on one's efforts and abilities'. It further mentions that the noun is synonym for Self-Dependence, Self-Subsistence, Self-Sufficiency and Self-Support. The Cambridge dictionary defines Self-Reliance as 'the ability to depend on yourself or your own abilities'. Collins dictionary states that 'self-reliance is the ability to do things and make decisions by yourself, without needing other people to help you'.

Many scholars have dwelt upon the topic in a wider perspective. The most widely accepted argument put forward is about one's progress through the phases of dependence, independence and interdependence. The initial phase is that of dependence, the second is that of independence but the third and apex phase is that of interdependence. Acclaimed management Guru Covey, S. R. (1991) has elaborated that argument in his popular book and management training genre – 'Seven Habits of Highly Effective People'.

In the definition 'you' or 'one' can be an individual, a group of people, an organisation, a society or humanity as a whole. It is that definition of 'one' that provides the context to different situations. For the purpose of this paper, the Merriam-Webster dictionary definition is taken as the base.

Self-Reliance Research from Organizational Perspective

The topic of Self-Reliance has been a subject of research in both academia and business. A vast body of knowledge exists in both qualitative and quantitative research form.

Sniderman, P. M., & Brody, R. A. (1977) analysed data gathered by the Centre of Political Studies in the 1972 US Presidential election. The paper draws very interesting conclusions. It finds that some of the personal problems get translated into political demands when the citizens feel that the government ought to take care of their personal problems. The authors conclude that although there have been a variety of views about the governmental role in addressing personal problems, the society believed firmly in Self-Reliance. Interestingly the topic of Self-Reliance has a support amongst advantaged and disadvantaged as well as with poorly educated and well-educated sections of the society.

In the modern times when the voices of Corporate Social Responsibility (CSR) and Environmental protection are finding more acceptance, the research carried out by Crouter, A. C., & Garbarino, J. (1982) provides an interesting interpretation of Corporate Self-Reliance. As per them, Corporate Self-Reliance serves the initial step towards the development of a sustainable society. They studied roles of labour-management committee, worker-ownership strategy, employee-based family support system and participative work as essential components of Corporate Self-Reliance. The researchers found that the group of employees having a sense of Self-Reliance were able to provide products with better quality, lesser waste and lesser cost than those who were being managed exclusively by experts.

The concept of Self-Reliance is not an absolute one; its interpretation changes with change in context. Li, L., & Qian, G. (2008) conducted a detailed study to understand how small scale, medium scale and large-scale organisations evaluate Self-Reliance of a partnership option while exploring entry into new markets. They

highlighted the need for partnership as against Self-Reliance when it comes to higher promotional efforts needed to make a market entry. The promotions need to match the local culture and it's in that, that the local resident partners are more helpful to ensure the same than to depend upon Self-Reliance. When it comes to streamlining of the operations and improving the core competence, Self-Reliance is a better option. With a Self-Reliance mode, organisations can become more inward looking while in the partnership mode the externalisation helps in reducing risks in certain set ups. Although the study was conducted in technology led industries, the finding can resonate with other industry segments too.

The above studies illustrate various interpretations and importance that scholars attach to the topic of Self-Reliance. Most of the research expands the Self-Reliance concept towards organisational and industry sectors rather than restricting it at an individual personal level.

Organisations are built on collaboration and Self-Reliance assumes a different context there. To stay competitive in the market, organisations need to build skills, capabilities and a dynamic knowledge repository. The section briefly discusses Self-Reliance from the perspective of four dominant management theories.

i. Social Exchange Theory (SET)

American Sociologist, George Homans proposed the concept of Social Exchanges which later got adapted in scientific and academic arena as 'Social Exchange Theory' (SET). The theory talks about cost, benefits, expectations, rewards, punishment and alternatives. In simple words, the theory states that human beings are constantly evaluating costs and benefits in every relationship, not only knowingly but unknowingly too. The part of all such interactions that make a person feel motivated, positive, satisfied and energetic, form benefits. The ones that emotionally or financially drain a person out or make the person feel low or dejected, are costs. Persons like to increase benefits while reducing or eliminating costs. Persons do not calculate cost-benefits in each of the discrete transactions but expect benefits to be more than costs at an aggregate level. They expect to get appreciated and rewarded for the good work done (as perceived by them). They also look forward to others appreciating their work, as it is nothing but the reward side of the equation. If they do not get appreciated for good work, they not only consider reward being equal to zero, but consider it as a punishment. If someone gets rewarded constantly but not the person per se, then that person thinks that it is due to favouritism; that may be true to a certain extent but not entirely. People try to stay in relationships that gives them more benefits and more rewards and less costs and less punishments (including financial and non-financial).

The theory clearly explains that one is dependent upon others in the group and hence Self-Reliance even from the perspective of one's own motivation is not absolute. Refer Figure-1.

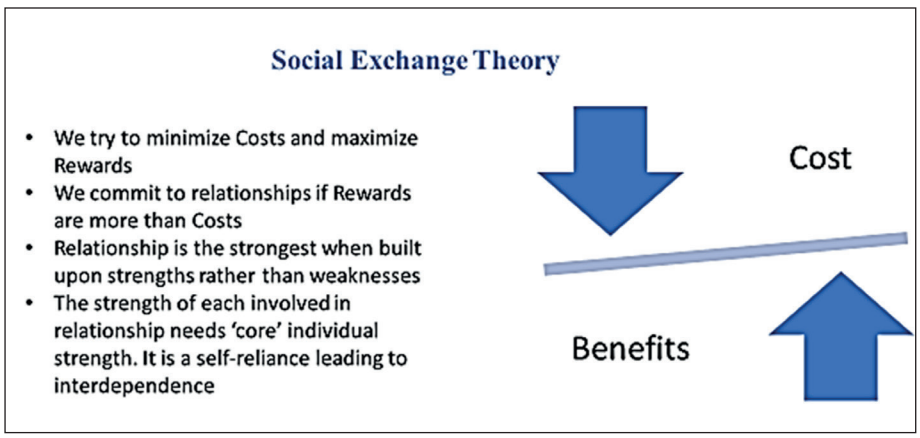

Figure-1: Social Exchange Theory

ii.. Core Competence Theory (CCT)

C. K. Prahlad and Garry Hamel pioneered the theory of core competence, which advocates that one needs to identify and nurture core strengths while the partners are to cater to the non-core part of activities. Understanding of core competence helps organisations to pursue excellence by concentrating efforts that can provide a long-term competitive advantage. Here

again, Self-Reliance is from the prism of dynamic advancements of core capabilities and skills.

Organisations need long term advantages to stay competitive. They need to invest into building core skills and capabilities on a continual basis. Those organisations that have a strong core can attract strong partners to form meaningful partnerships on strong footings. It is thus the core strength that is more important than mere willingness. The organisational studies clearly emphasise the importance of Self-Reliance when it comes to identifying and nurturing talent. Organisations that have a strong core are found to keep evolving in the dynamic and complex business environment. Although such Self-Reliance is necessary, it is not enough to stay competitive. The theory advocates both Self-Reliance and Interdependence as depicted in Figure 2.

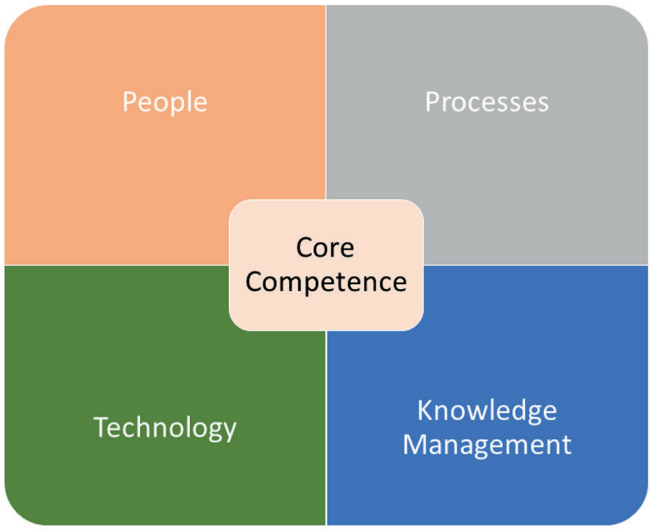

Figure-2: Core Competence Theory

iii. Resource Based View

Barney, J (1991) tried to find an answer to a simple yet critical question as to why some organisations perform better than others while operating in a similar business environment. The landmark paper continues to act as a reference for management studies over the past three decades. The research looked at a firms' competitive advantages through two perspectives - one was through analysis of the internal environment and second was through analysis of the external competitive environment.

The proposed model gained prominence as the VRIN model since it proposes resources as Valuable, Rare, Inimitable and Non-Substitutable. The resources could be either Tangible or Intangible, Heterogeneous and Immobile. Thus, if resources cannot be easily imitated by competition (Inimitable), if resources cannot get substituted by some other means or if the resources are rare and valuable then the competition finds it difficult to imitate success. Such resources help provide sustained competitive advantage to the organisation.

In this case, the focus is on building resources that are core to the business success. To build such resource pools, organizations need to invest a great deal of efforts. The theory is closer to Self-Reliance to the extent of nurturing such resource pools as depicted in Figure-3.

Figure-3: Resource Based View

iv. Knowledge Based View

Modern organisations are dynamic knowledge repositories. As knowledge is considered a key differentiator, the management of various aspects of knowledge becomes crucial. Knowledge Management comprises of four phases viz. Knowledge Identification, Knowledge Generation, Knowledge Acquisition and Knowledge Deployment. In all these four phases of Knowledge Management, the contribution of employees

is paramount. Both tacit and explicit knowledge forms are crucial to ensure organisational differential in the market place. The individual and collective team efforts go a long way in building healthy and dynamic knowledge systems. Organisations that are rich in such knowledge repository become more Self-Reliant.

Engineering consulting business needs deeper understanding and the expertise of many disciplines. It needs to leverage the practical experiences, gained individually and collectively, right at the design stages. The assets that these organizations design and eventually create are expected to last for long term. The organisations need to constantly keep improving. Both individual and collective knowledge generation and absorption needs to be a daily routine. Unless employees are deeply committed and collaborative, the Knowledge Repository cannot stay contemporary. Another important point that needs mention is to realise that the Knowledge is not an isolated island. It needs definite bridges and interfaces with the outside world. Hence, to that extent, organisations are never purely Self-Reliant but have a strong Interdependence too, as depicted in Figure-4.

Figure-4: Knowledge Based View

Conclusions

Organisations mainly comprise of people, process and collective knowledge. Self-Reliance in an organisational set up is nothing but Self-Reliance of a group built on the collective capabilities of each of its individual members, which when they are present in more than one person truly create a tremendous positive impact on the organisation. The basic understanding of how the individual is valued in the group and how the individual and the group drive each other determines how effective the group can be. Intra group collaboration can increase Self-Reliance. The Self-Reliant group members are found to deliver better on quality and innovations and can positively fuel organisational growth.

Various scholars and practitioners have provided their own interpretation of Self-Reliance. However, one commonality amongst all these thoughts highlights the need to understand its meaning through a larger perspective. The four dominant management theories discussed in the paper stress the need to form a strong core of Self-Reliance and Interdependence. That goal can be reached through the journey of Dependence and Self-Dependence. Hence, understanding of Self-Dependence is a crucial aspect of organisational and personal journey.

The strong core helps organisations to keep evolving. It helps to build relationship that are based upon strengths and understanding of the needs where others should improve. Only strong can attract strong to form a meaningful partnership. The organisations need to begin with Self-Reliance to effectively work with other Self-Reliant partners to expand their capabilities and reach. The cycle of Self-Reliance and Interdependence is thus a perpetual one. One feeds and supports the other and keeps expanding to provide a real long-term competitive advantage. The four theories are depicted in Figure-5 with respect to Self-Reliance and Interdependence.

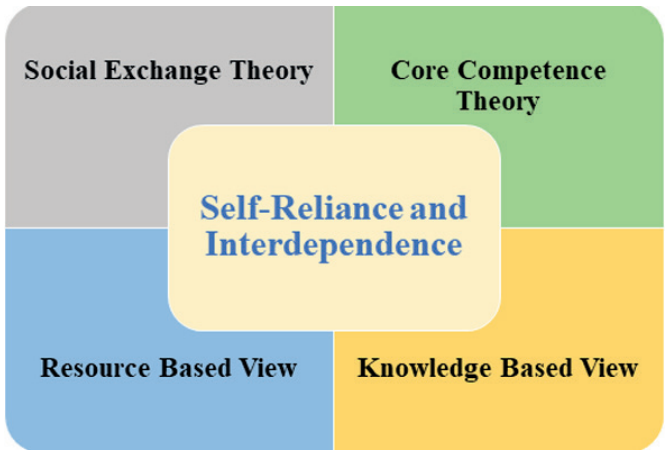

Figure-5: Self-Reliance and Interdependence Theories

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Eureka! DESIGN | INNOVATE | ENGINEER

Vaulted concrete floor cuts carbon by 60 per cent

Written by: Andrew Wade | Published: 22 February 2022

A UK consortium has developed a new style of vaulted concrete floor that could significantly reduce the environmental impact of the construction industry.

(Credit: ACORN)

The 'thin shell' vaulted floor was developed by a team of structural engineers, mathematicians and manufacturing experts at the Universities of Bath, Cambridge and Dundee. Compared with a traditional flat slab floor, the innovation is said to use 75 per cent less concrete and 60 per cent less carbon in its construction.

The curved vault-shaped structure is covered by standard raised floor panels to create a level surface. Created by the UKRI-funded ACORN (Automating Concrete Construction) research project, the vault-shaped floor design takes advantage of concrete's 'inherent natural properties and strengths', according to the researchers.

"Achieving the net-zero targets recently ratified at the COP26 conference will require significant change by the construction industry, which is responsible for about half of the UK's total emissions," said Dr Paul Shepherd, principal investigator for ACORN and a reader in Bath University's Department of Architecture and Civil Engineering.

04

Road to Net-Zero through Atmanirbhar Bharat

Kuljit Singh Popli
Former CMD
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Some of the biggest challenges that the World faces today are those on account of Climate Change and which will adversely affect the future generations. To overcome the above challenges and contain the Global temperature rise to 1.5 to 2^0C, the World has to accelerate towards a non-fossil fuel economy.

More than 80% of the energy consumption by all large world economies except France and Brazil is from fossil fuels. The World has already consumed 83% of its budget for restricting the temperature rise of 1.5^0C. A growing number of countries are pledging to reach net-zero carbon dioxide emissions by mid-century in line with the goal of limiting the temperature rise to 1.5^0C to 2^0C. Achieving the deep or full decarbonisation of economies will require concerted and wide-ranging action across all countries.

Taking the case of India alone, India's per capita energy use in KWh terms is 6,360, which is one-twelfth of the 79,131 KWh for US and one fourth of the 24,938 KWh for China. Out of that 5,893 KWh comes from fossil fuels which is more than 90% of the total energy consumption. Inspite of very low per capita consumption India is the third largest emitter after China and US. At present 75% of India's oil and gas needs are met through imports, which also has associated Geopolitical risks which can expose the economy to external shocks and threat to the energy supply chain. India therefore has not only to reduce its emissions but also reduce its dependence on import of fossil fuels.

In November 2021, the Hon'ble Prime Minister made a commitment at COP 26 that India will achieve net zero target by 2070. He further enhanced India's Green energy target from 450 GW to 500 GW by 2030. Out of the above target more than 280 GW would be from Solar and more than 140 GW from Wind. More than 80% of wind turbine components are made in India and India also exports wind turbines. However, that is not so for Solar. More than 80% of Solar panels are imported, thereby contributing to outgo of capital as well as putting India on supply chain risk. If India has to achieve the net zero target, it would only be possible through massive induction of Renewable Energy (RE) into the grid and thus reducing fossil fuel consumption or carbon capture which is not a viable technology at present.

As per International Renewable Energy report (IRENA), the present share of electricity in the total energy mix is 18% to 20%, but that share would increase to 49% by 2050, out of which Renewable Energy (RE) would contribute 85%. Solar Energy would contribute 60% out of the above 85% electricity generation from Renewables by 2050.

For India as well, CEA has carried out a detailed study on the optimal mix for 450 GW of RE (target by 2030) and worked out 280 GW from Solar and 140 GW from Wind. Since Solar energy would be contributing the maximum share to the grid, it is extremely important that India's dependence on import of cells and modules

should end. Hence, the Government of India has already announced a Production Linked Incentive (PLI) scheme for domestic manufacture of polysilicon to wafer to cell and modules and enhanced the budget for it to INR 24,000 crores in the budget for 2022-23, which is up from the INR 45,00 crores announced last year. The scheme aims at adding 10,000 MW manufacturing capacity of integrated Solar PV cells and modules entailing direct investment of INR 17,200 crores. With increase in allocation to INR 24,000 crores the quantum of investments and domestic manufacturing capacity envisaged under PLI scheme would further increase and make India self-reliant and even exporter of modules.

A stable grid with 80 % energy from Renewable sources shall require huge short- and long-term storages to take care of intermittency, variability, and balancing of the grid. The Government has done well to have come out with the PLI scheme for Advanced Chemistry Cell (ACC) Battery Storage for achieving manufacturing capacity of 50 GWHr of ACC for enhancing manufacturing capabilities; the budgetary outlay for that is INR 18,100 crores.

The PLI scheme for Advanced Chemistry Cell (ACC) along with PLI scheme already launched for the automotive sector (INR 25,938 crores) and the Faster Adoption of Manufacturing of Electric Vehicles (FAME) (INR 10,000 crores) scheme will enable India to leap frog from traditional fossil fuel-based automobile transportation system to environmentally cleaner, sustainable, advanced and more efficient electric based vehicles.

Both the schemes for cells and modules and storage batteries have elicited good response from the Industry. Further, the Government has also come out with a policy on Green Hydrogen which can provide long term storage and can help to decarbonise sectors like steel, cement, shipping, aviation, long distance trucking, etc. Today the total Hydrogen production is 70 MT out of which only 4% is produced through electrolysis globally. The new policy is aimed at production of 5 million tonnes of Green Hydrogen by 2030 and making India an export hub of clean fuel. The new policy offers 25 years of free power transmission for any new renewable energy plants set up to supply power for supply of Green Hydrogen production before July 2025. That would help in creation of demand for Green Ammonia or Green Hydrogen for fertiliser, steel and oil refining where Green Hydrogen may become cost competitive with Grey Hydrogen. The policy also provides for banking of excess RE for production of Green Hydrogen for 30 days and developing a single portal for all clearances with priority on connectivity. The Green Hydrogen producers would also be provided land by port authorities for storage in bunkers before export.

The Government is also going to issue a mandate for steel and fertiliser plants and also oil refineries to procure 15 to 20% of their Ammonia or Hydrogen requirement through Green Hydrogen. The policy would thus facilitate accelerated decarbonisation and help India become an export hub for Green Hydrogen.

For India to achieve the Sustainable Development Goals (SDGs), then Social, Economic, and Environmental (SEE) dimensions have to be addressed in a balanced and sustainable manner. Out of the 17 SDGs, five SDGs are closely linked, and three SDGs are moderately associated with Renewable Energy. Thus, by achieving self-reliance in the energy sector, India can achieve many SDGs.

On 12th May 2020, the Prime Minister had raised a clarion call to the nation and kick started the Atmanirbhar Bharat Abhiyaan (Self-reliant India campaign) and also announced the Special economic and comprehensive package of INR 20 lakh crores - equivalent to 10% of India's GDP, to fight the COVID-19 pandemic in India. The aim is to make the country and its citizens independent and self-reliant in all senses. He further outlined five pillars of Atmanirbhar Bharat – Economy, Infrastructure, System, Vibrant Demography and Demand. India, today spends over Rs 12 lakh crore on energy imports every year. While India is 85% dependent on imports for meeting its oil needs, overseas supplies make up for roughly half of the local requirement for natural gas as well. Hence, India can truly become self-

reliant only when it achieves self-reliance in the Energy sector. The Hon'ble Prime Minister had said that for "India to progress, for Atmanirbhar Bharat, energy independence is necessary" and that "India has to take a pledge that it will be energy independent by the year we celebrate 100th year of Independence."

Green Energy has a tremendous potential in contributing to income, employment, and entrepreneurship and undoubtedly foster sustainable development. In addition to job and income generation, it opens up opportunities/ avenues for investment and markets for new products and services. Therefore, India should focus on achieving deep decarbonisation and self-reliance in the Energy Sector. As per the IRENA Report, dramatic emission reductions are both technologically feasible and economically affordable. Deeper decarbonisation perspective suggests possibilities for accelerated action to bring down CO2 emissions while bringing an economic payback of between USD 1.5 and USD 5 for every USD 1 spent on energy transition (IRENA,2020).

Therefore, the path to Sustainable Development and Net-Zero will be accelerated by a Atmanirbhar or self-reliant India by its Energy Generation, Storage and Supply.

COUNCIL ON ENERGY, ENVIRONMENT AND WATER

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Report

Sustainable Agriculture in India 2021

What We Know and How to Scale Up

Niti Gupta, Shanal Pradhan, Abhishek Jain, Nayha Patel

April 2021 | Food, Land and Water (/food-land-and-water)

Suggested citation: Gupta, Niti, Shanal Pradhan, Abhishek Jain (https://www.ceew.in/abhishek-jain) and Nayha Patel. 2021.

Overview

This study, in collaboration with the Food and Land Use Coalition (FOLU), provides an overview of the current state of sustainable agriculture practices and systems (SAPS) …

The study identifies 16 SAPSs – including agroforestry, crop rotation, rainwater harvesting, organic farming and natural farming investigative lens. Based on an in-depth review of 16 practices, it concludes that sustainable agriculture is far from mainstream in India. Further, it proposes several measures for promoting SAPSs, including restructured government support and rigorous evidence generation.

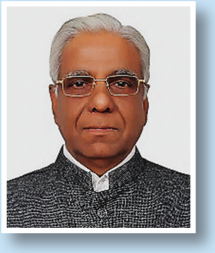
16 Most Promising Practices in Sustainable Agriculture

Organic Farming Agroforestry Natural Farming System of Rice Intensification Precision Farming Conservation Agriculture Crop Rotation and Intercropping Cover Crops and Mulching Integrated Pest Management Vermicomposting Biodynamic Farming Contour Farming Integrated Farming Systems Rainwater Harvesting Artificial Recharge of Groundwater Floating Farming Permaculture

Source: https://www.ceew.in/publications/sustainable-agriculture-india

05

India Centric Technology & Engineering for Atmanirbhar Bharat



S B Dangayach
Founder Trustee
Innovative Thought Forum

Prologue

India is celebrating 75 years of Independence that have witnessed ups and downs. Despite freedom on the physical plane, the people in general are continuing to suffer from mental and intellectual inadequacies resulting into adherence to thoughts and practices from the Western world either in pristine form or modified versions. Whereas in the initial decades the Western models of socialism or communism had been adopted, but they gave way to capitalism in the later decades. The inability to aim for an India centric economic policy is clear from the fact that *"Arthashastra"* of Kautilya, now lauded as the founder of modern economics, is absent from libraries and curricula of all economics and business schools of India, albeit it would need to be modified to suit the present socio-political culture.

The diffidence of the people is also obvious from a reading of the essay on "Science" in Wikipedia where India is conspicuously absent as a contributor in the fields of mathematics, astronomy, health, etc. despite having been the pioneers in the world. The main reason being that the thought and learning processes plus the omnipresent media have been allowed to be West dominated.

In the field of finance, persons and businesses concerned are oblivious to drainage of India's wealth in offshore tax havens controlled by old colonisers and lack the courage to question the defective financial architecture harming the country.

In the backdrop of the above developments, the clarion call for *Atmanirbhar Bharat* is timely and laudable.

As a thought is needed to be translated into action, associations such as the Innovative Thought Forum (ITF) have arranged round tables on the theme of "Pragmatic Ways for Atmanirbhar Bharat" on many subjects recently and have come up with an anthology containing 75 articles in 12 areas, by India centric thought leaders and experts, to suggest feasible and practical ways for making India stronger.

a) Foreign Trade
b) Internal Trade and e Commerce
c) Finance and Taxation
d) Health and Wellness
e) Skilling and Employment
f) Education and Research
g) Environment and Climate Change
h) Energy and Water
i) Farming, Fertilisers and Foods
j) Land and Infrastructure
k) Defence and Space
l) Technology and Entrepreneurship

Technology and Engineering for Real Solutions

Technology is the application of scientific knowledge, basic and applied, for practical purposes and is thus the sum total of all known techniques, skills, methods and

processes used in building and the production of desired structures, goods and providing services.

Engineering, on the other hand, is the use and application of science and technology to design and build machines, structures, etc., both in physical and virtual space.

For sake of simplification, the term engineering in this article will cover both engineering and technology.

India is unique in most ways by having distinctive sets of problems in every domain. The current paradigm of globalisation predicated on "one size fits all" is not going to serve the country well and hence there is a need to put India first and evolve solutions that address its needs optimally through a combination of local solutions and adapted global prescriptions.

Although there are nearly 7000 engineering institutions producing over one million engineers a year, it is found that the country is saddled with nagging problems because the engineers are not applying their mind nor putting in time and efforts to find solutions using their innate and acquired knowledge. Inadequate monetary benefits from such pursuit also drives engineers to other lucrative areas or emigration to other countries.

With resetting of the vision and an India centric perspective, dramatic changes could be brought about in all the spheres. A few of the engineering efforts which would really help India in becoming *Atmanirbhar* are Agriculture and Food, Renewable and Green Energy, Housing and Infrastructure, Waste to Resource or Environment, Health, and, Education and Skilling

Agriculture and Food

Agriculture has deep connection with water, energy, food, fertiliser, nutrition, health and environment. Agriculture Engineering encompasses science and the principles relating to the various disciplines of food science, environmental, mechanical, civil, electrical, chemical, and software engineering to improve the efficiency of farms and agribusiness enterprises as well as to ensure sustainability of natural and renewable resources. A few India centric areas for agriculture engineering and food that need attention are:

- Massive production of low-cost Tools and Equipment for farming.
- Decentralised Cold Storage facilities using a mix of renewables and fossil.
- Decentralised Dehydration facilities using renewables.
- Decentralised Agri processing facilities.
- Decentralised or Cooperative Organic fertiliser production using efficient biogas plants.
- IT opensource solutions for a variety of Agri activities.
- GIS for agriculture.
- Cultivation of Organic Medicinal Plants and conversion into Nutritional and Medical products.
- Hydroponic, Aquaponic and Aeroponic systems for cultivation at desired places.
- Development of biofertlisers and organic fertilisers for production and widespread use, and
- Engineering for Rainwater collection, storage and efficient use for multi cropping.

Renewable and Green Energy

The Energy sector is undergoing a rapid change with

renewable energy now lower in cost than that from fossil fuels. Solar Power is being contracted at less than Rs 3 per unit in India and Rs. 2 in many parts of the world without any subsidy. Wind Power is also becoming cheaper all over the world and would see further decline with technical advancements both in onshore and offshore installations. The inherent drawback of discontinuity of renewable power availability will be thing of the past with progress in cheaper power storage technologies.

India is a major importer of fossil fuel and will gain a lot by focusing on renewables in an appropriate way. The focus of the policy makers so far has been on the supply side and very little work has so far been done on the demand side despite some resolutions by top leaders. In a recent survey conducted by the Rural Electrification Corporation (REC) it has been learnt that the demand of power of rural enterprises is for 10/12 hours and that for agriculture for a few hours. India centric and design centric thinking as enumerated below, throws up many pathways for reducing import dependency and improving the country's prosperity.

- Solar installations for pumping water - there is a perfect match in the discontinuous demand and supply.
- Solar installations in all manufacturing units to meet their demand partially.
- Decentralised Microgrids using renewables like solar, biogas, biomass, wind, small hydro, etc.
- Small Windmills for low-speed areas.
- Biogas plants with suitable improvements for production of gas, power and fertiliser from animal and kitchen waste.
- Engineering for improving efficiency of use of power in all sectors: manufacturing, transport, agriculture and buildings.
- Engineering for deployment of solar thermal applications in cooking, heating and industrial processing.
- Engineering for hybrid use of solar and fossil fuel thermal energy.
- Engineering for production and use of hydrogen for many uses like in heavy vehicles, buses, etc. and decentralised power grids, and
- Engineering for energy storage - hydro, batteries, phase change materials, hydrogen, etc.

Housing and Infrastructure

Housing is a basic need. Due to a mythical shortage of land and the complex regulatory or licence regime, shortage of proper *pucca* housing is faced in many parts of the country and that has given rise to mushrooming of slums and unhealthy living quarters.

Infrastructural requirements are really humongous and need judicious use of technology and engineering. Some of the steps that can help the country are:

- Using GIS and related technologies for identification of Wasted Lands, i.e., land parcels within exiting built environments, that have not been in use for last 20 years and will not be put to use for the next 20 years. Wasted Lands are thus different and distinct from Waste Lands. The Wasted Lands should be incorporated into the Master Plan of the built environment.
- Using a suite of technologies to convert Wastelands for agriculture into useful lands for aquaculture, sericulture, poultry, etc. in Public-Private Partnership (PPP) or Public-Private People Partnership (PPPP) mode as well as for housing.
- Using IT to manage such leased parcels for Wastelands and Owned parcels of Wasted Lands for designated purposes.
- Technologies for efficient usage of energy in built spaces.
- Technologies for efficient usage and recycling of water in built spaces.
- Mechanised or semi mechanised methods of construction for better quality, and
- IT for online approvals of plans and monitoring of the approved plans.

Waste and Environment

Every activity generates waste and the proponents of Circular Economy demonstrate that every waste could be used as a resource for some other place or thing. There are many engineering methods to give shape to this dictum. A few feasible low hanging fruits to tap are:

- All animal waste like *Gobar* and food waste is great for biogas and organic fertiliser. Biogas plants to suit different needs can be designed and engineered to convert the waste into useful products.
- Technologies for treating sewage for use as industrial water or agricultural water.
- Low-cost biotech solution for treating human waste at site for maintaining hygiene of toilets all over India
- Technologies for sorting, transportation, managing and processing dry solid wastes.
- Perfection of technologies for use of plastic waste in road construction that can improve the quality of roads and thus also improve the environment. Plastic waste could also be converted/ moulded for use in other building materials.
- Knowhow for use of Fly Ash in agriculture and forests to increase output.
- Low-cost technologies for ZLD (Zero Liquid Discharge), and
- Clean production technologies to reduce air pollution.

Health

Health is recognised as a prerequisite for all pursuits -*Dharm, Arth, Kam,* and *Moksh*.

The health sector has evolved and now involves various branches of science and engineering such as agriculture, nutritional sciences, biomedical engineering, phytochemical engineering, public health engineering, chemical engineering, biotech, etc. A few solutions that stem from these are:

- Biotech Engineering for affordable production of specific immunity tools like vaccines, nosodes, etc.
- IT for telemedicine to deliver quality service and counsel all over the country.
- Nanotechnology based solutions for safer and better medicines.
- Engineering for improved medical devices and surgical tools, and
- Engineering for on-site and low-cost disinfection of water to improve public health.

Education and Skilling

Education is the foundation of every successful civilisation. Training or skilling has proved to be a game changer in the competitive world and is the backbone of developed nations who give it equitable place in all their plans.

Education technology, in short called Edutech, has shown it's immense utility in the current pandemic. The country is endowed with an abundant population that can be a more valuable resource with proper education and training, for all ages, by combination of centralised and decentralised options. Building flexibility in the processes while focussing on the outcomes and reducing controls in the education field, can reap rich dividends.

A few transformational engineering initiatives in this domain worth considering are:

- Building platforms for open-source online education, training and skilling
- Building platforms for involving willing retired teachers and trainers to impart knowledge online and offline
- Building platforms for RPL (Recognition for Prior Learning) by diluting entrance criteria in time with India's needs and by having a two-tier certification system
  - Type A for people with poor literary or numerary abilities or skills
  - Type B for learners with proper literacy and numerary skill sets
- Technology for delivering skills or knowledge to people in their own habitats
- Using ICT to impart education and skills at optimal cost while enhancing each
- Priority to skilling of agricultural and construction workers for all round improvement

- Assessing demand of India and recasting education and skill programmes to meet it
- Incorporating simple modules for basics of business in all courses at secondary and higher levels for sharpening entrepreneurial skills of micro and small enterprises
- Digital literacy for various sections of the society

The examples given above can provide sustainable results if a few cardinal factors are incorporated in all the domains.

- Designing or engineering for proper utilisation of the resources.
- Waste Reduction/ Reuse/ Recycle / Recover/ Recreate (i.e. use the 5R principle)
- Integrated and holistic Costing taking into account Capex and Opex and accounting for the full life of the facility.
- Continuous Upgrading of Knowledge and Skills of all Human Resources for optimum quality and quantity outputs.
- Concomitant changes in Education, Research and Programmes for India centric thinking and action.

Conclusions

The expanse of Engineering is ever increasing and now even Financial Engineering is commonplace. In the Indian context, conversion of engineering solutions into enterprises would hold the key to the success of a mission. The Start-up ecosystem for local and global markets would be an important lever for success. A confident engineering community to efficiently solve the problems of India without sacrificing their abilities to win global markets is the need of the hour.

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06

Atmanirbhar Bharat – A Continuous Journey Towards Excellence and Self-realization

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Introduction

India and its people have always given out the best to the inhabitants of the world. This country has been the epitome of knowledge, spiritualism, and wealth for ages. Many of the foundational aspects of modern civilization – science, mathematics, technology, medicine, culture, sports, economy, governance, public administration were developed by philosophers and practitioners in this country. India had never had to invade any country by physical force but had spread its influence far and wide through ideals that have benefitted humanity. The land and its people have absorbed and assimilated even its invaders who have slowly mixed with the populace to further enrich the country through diversity and inclusiveness. It was only during the colonial rule that the country lost its exalted position. The administrative servitude that was thrust upon the people led to the gradual breakdown of the fabric of self-reliance and the people started to look towards others for leadership and guidance. The vision of a self- reliant nation has been voiced time and again through the indomitable spirit of persons such as Swami Vivekananda, Gurudev Rabindra Nath Tagore, and Rishi Aurobindo. Swamiji strongly believed that India would emerge as a world leader when its people attained self-consciousness of the immense power that lay within themselves. He called for the citizens to unite in thoughts and spirit so that a new nation would emerge from each nook and corner of the country from amongst the citizens in all professions and walks of life.

The Spirit of Atmanirbhar Bharat

Many of the social and political movements during the freedom struggle can also be viewed as a call for self-reliance. Some of the more famous ideas associated with the concept are "Swaraj is my birthright" by Bal Gangadhar Tilak, "Swaraj in Ideas" call given by Krishna Chandra Bhattacharyya and the concept of "Hind Swaraj" propounded by Mohandas Karamchand Gandhi.[2] The "Swadeshi" movement started in 1905 aimed to curb the reliance on foreign goods. It caused overall imports to fall by 25 percent thus helping the Indian merchants to increase prices and profits. The Tata Iron and Steel Company (TISCO) started operation on India's first indigenous steelworks reducing dependence on Belgian steel imports.[3]

The policies under the British rule had led to draining of about 4% of the national income of India in the latter half of the nineteenth century. The economic theory of "the Drain" was put forward by Dadabhai Naoroji and Romeshchandra Dutt. They had argued that the revenue drained out from India paid for the expenses of the British civil servants and the Indian Army used by the British throughout the world and that converted India from a prosperous, indigenous economy to a subservient colonial economy.[3]

Rise of Self-Reliant India

The spirit of nationalist movement underlined the thoughts

that led to the National Planning Committee in 1938 under Indian National Congress President Subhas Chandra Bose to make India an economic unit, industrialized and self-sufficient. The Bombay Plan developed by J. R. D. Tata, G. D. Birla, A. Dalal, and others aimed to make the country self-sufficient by increasing the role of the state in all aspects of economy. The first major policy document of independent India, the Industrial Policy Resolution of 1948 promulgated a mixed economy consensus as national goal, taking cognizance of economic models of Soviet Union, South Korea, Taiwan, and Brazil. That led to the impetus towards developing the nation. Later the Green Revolution and White Revolutions resulted in India becoming self-sufficient in agriculture and milk production.[1]

The Government of India set up the Planning Commission in 1950 with an emphasis on developing the public sector - for setting up of basic and heavy industries directly funded by the state. The Planning Commission was responsible for assessing the resources in the country, augmenting them, plan for their balanced utilization and determine the priorities for use.[5] The government made large investment in the sectors of education, energy, railways, and irrigation which helped the country become self-sufficient in agriculture, capital goods and consumer products. The planning process also stressed upon social justice, governance, employment generation, eradication of poverty, and development of health and skill of the population of the country. The successful planning helped convert India from impoverished state to an economic powerhouse.[6]

Realizing the Vision of Atmanirbhar India

This paper is a journey through a few case studies of the struggles and hardships that pioneers who charted out the path for regaining the status of India as a leader in the modern world had to face. There were efforts from many individual entrepreneurs and strategic planning by visionaries that helped the country regain self-reliance in many aspects of civil society and emerge as a leader.

Bombay Mills: Indian fabrics were held in great esteem and coveted for their fine quality and craftmanship. During the British rule, the situation changed when cotton was exported and cloth made from that imported into India. That trade imbalance greatly harmed the handloom based indigenous textile industry. Modernization of the industry to compete with the efficiencies of mechanized processing was started with the establishment of "The Bombay Spinning Mills" set up in 1854 by Cowasji Nanabhai Davar. The cotton mill industry grew rapidly during American Civil War mostly under Indian ownership. The boom also spurred development of associated wealth through land development, cotton pressing, shipping, insurance and joint stocks that resulted in Bombay (Mumbai as was known then) becoming the financial hub of the country.[9]

Photo-1: India United Mills No. 1, Parel [Wikimedia commons]

Photo-2: Abandoned machinery at Madhusudan Mills, Lower Parel [Wikimedia commons]

Bengal Chemicals: One of the first production unit set up indigenously was Bengal Chemicals Works in 1892 by renowned scientist and entrepreneur Acharya Prafulla Chandra Ray, which aimed to foster the spirit

of entrepreneurship in the youth and provide alternate job opportunities. It was recognized as the pathbreaker in technology fuelled business enterprise and lesson to capitalists in the country.[7] It was incorporated in 1901 as Bengal Chemical and Pharmaceutical Works and operates as a profitable nationalized unit. The company started with production of drugs, chemicals, and herbal products and gradually diversified into industrial chemicals, bulk drugs, perfumes, cosmetics, toiletries, hospital, and surgical equipment among others.

Photo-3: Entrance of Bengal Chemicals & Pharmaceuticals Limited, Kolkata [Wikimedia commons]

Photo-4: Bengal Chemicals & Pharmaceuticals Ltd [ibgnews.com/2020/09/10]

Safety Matchbox industry: Safety matchbox was first imported from Europe, notably Germany, Austria and Sweden in the late nineteenth century. The initial attempts by swadeshi units and "The Indian Match Factory Limited" and "Bengal Safety Match Manufacturing Company" at Salkia, Howrah ended in failures. Successful attempt at indigenous manufacturing was started around 1910 by Japanese immigrants and by C. A. Mohammad at Kolkata who brought in technology from Japan. The match industry then shifted to Ramnathapuram and Tirunelveli districts of Tamil Nadu, pioneered by P. Iya Nadar and A. Shanmuga Nadar who learnt the process in Calcutta. The industry developed as cottage and handicraft industry and continues in that form. The Western India Match Company (WIMCO) started operation in 1924 with Swedish manufacturing patronage. Both the sectors are thriving to this day; the small-scale handmade sector with government support and tax benefits, and WIMCO as the only large-scale operation.[10,11]

Photo-5: Safety Matchbox Covers - Sivakasi[10]

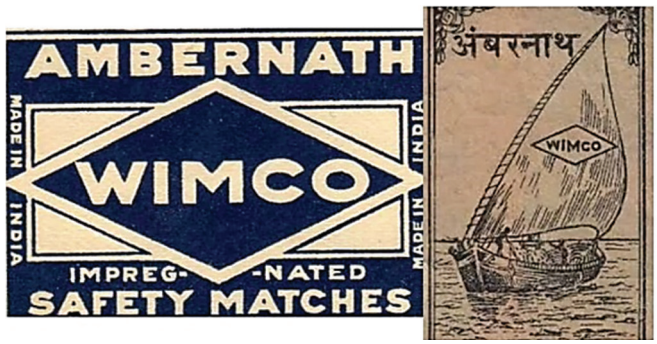

Photo-6: Safety Matchbox covers - WIMCO[10]

Space Research Program: Space research was started indigenously in India by scientists like S. K. Mitra, C. V. Raman and Meghnad Saha. Vikram Sarabhai and Homi Jehangir Bhaba laid the foundations of organized space research in India under the Department of Atomic Energy (DAE). The Indian National Committee for Space

Research (INCOSPAR) formed in 1962 was involved in setting up the Thumba Equatorial Rocket Launching Station (TERLS) for research of the upper atmosphere. The Indian Space Research Organization (ISRO) formed in 1969 and placed under the Department of Space (DOS) in 1972 then took over the task of developing, launching, and operating satellites including development of indigenously developed rockets with technical assistance from the Soviet Space Program.[12,13] The most creditable achievement was the development of the cryogenic engine used for launching of the geosynchronous satellites (GSLV). The efforts towards development of cryogenic engines began in 1980 through negotiations with United States, France, Japan, and Russia for technology sharing. When a deal with Russian space agency Glavkosmos was finalized in 1991 for supply of two engines and transfer of technology, the US blocked the deal and allowed only supply of seven such engines. These were used by ISRO for initial GSLV program and ISRO took on the arduous challenge of independently developing the technology. Two decades of hard work, failures and learning finally culminated in successful launch in 2014 of the GSLV with third generation cryogenic engine. ISRO also overcame another hurdle imposed by the US in declining to help with Global Positioning System (GPS) during the Kargil War of 1999 which led to the development of the indigenous satellite navigation system - the Indian Regional Navigation Satellite System (IRNSS), with an operational name of NavIC.[14]

ISRO continues to lead in space research and its repertoire includes projects to develop heavy lift launchers (more than 3t payload), human spaceflight projects, reusable rockets, semi-cryogenic engines, single and two-stage to orbit vehicles and composite materials for space applications. It is globally considered a leading agency in space research.

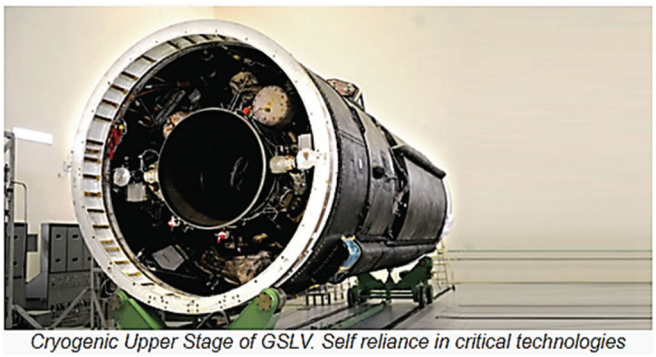

Photo-7: Cryogenic Upper stage of GSLV[12]

Photo-8: Arcas rocket loading into launch tube, Thumba[13]

Photo-9: GSLV MkIII first launch delivering GAST-19 satellite[14]

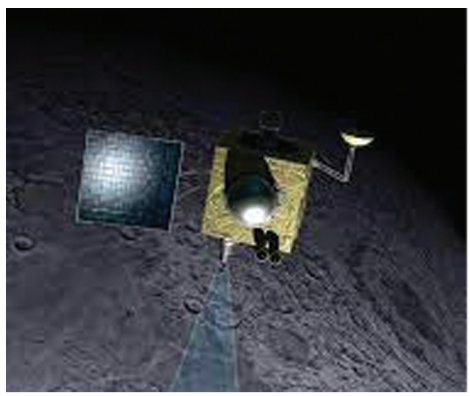

Photo-10: Chandrayan 1 [space.com]

Nuclear Reactor Technology – The presence of radioactive minerals in India was studied by the Geological Survey of India (GSI) in 1901 but no effort towards using the resources were undertaken under British rule. India followed a strong disarmament policy, distancing itself from nuclear weapon related work, after independence. However, under the Department of Atomic Energy (DAE) peaceful and civil uses of nuclear energy started to develop with technological assistance from countries like United Kingdom and Canada. Canada assisted in development of NRX type reactor and provided a 40MW CIRUS type reactor solely for research purpose which went into operation in 1961. The first commercial reactors based on CANDU technology supplied free of cost by the Atomic Energy of Canada in 1963 (RAPP-1) and 1966 (RAPP-2) which had strong safeguards for use against military purposes. However, the CIRUS reactor had no such safeguards and enriched plutonium from this reactor was used to conduct peaceful nuclear explosion (PNE) at Pokhran in 1974. That had a global adverse effect with United States and Canada terminating all assistance agreements.[15,16] India was put under nuclear embargo in 1978 with the promulgation of the Nuclear Non-Proliferation Act (NNPA). Russia continued to support the Indian nuclear program with an agreement in 1988 for building of two 1000MW light water nuclear reactors at Kudankulam in Tamil Nadu. The embargo to India's nuclear development was further expanded in 1992 when the Nuclear Suppliers Group (NSG) set full-scope safeguards for nuclear trade with non-weapon states. More tests conducted in 1998 under political compulsions resulted in further setback to getting assistance for the nuclear power program.[17] India continued with developing its own nuclear program despite such non-cooperation from western nations. New reactors continued to be added – 220 MWe reactors at Narora, Kakrapar and Kaiga and 540 MWe heavy water reactor at Tarapore Atomic Power Station (:- Uranium mining and processing facilities were developed at Jadugoda in Jharkhand and Meghalaya. Later the relations with western countries were re-established with many of the plants meeting the safeguard requirements of International Atomic Energy Agency (IAEA).[18]

Food Sufficiency: Devastating famines have occurred in India affecting millions of people, due to deficiency of grain production and unavailability of money with peasants that was being channelled to the landlords. The inequalities in food distribution further aggravated the famine situations. Indian agriculture was heavily dependent on weather and manual labour leading to low yields. British administrative policies of replacing subsistence crop-based agriculture with export-oriented cultivation was vital to fuel the economy of the British empire but it took a heavy toll on food crop farming aggravating the famines while famine relief was kept minimal.[19]

Institutional reforms in agricultural sector after independence could not improve agricultural practices. By the end of 1960s, India had to import wheat to feed its increasing population. The Green Revolution that was started in 1968 along the lines of success in Mexico dramatically altered the grain production in India. The movement was led in India by M. S. Swaminathan leveraging the agricultural research of Norman E. Borlaug. In a short period, it converted the agricultural sector to an industrialized system using modern practices, high yield and resistant seeds, mechanized farming, irrigation and use of fertilizers and pesticides. The move was funded by the US and Indian governments and the Ford and Rockefeller Foundation. The growth achieved was quick and spectacular – India became self-sufficient in cereals in 1974. Data from the Food and Agricultural Organization show that between 1961 to 2001 when the population of India had more than doubled from 452 million to over one billion, grain production went up almost three times from 87 million tonnes to 231 million tonnes even though the cultivated land area increased a mere 8%.[20,21] The Green Revolution which spread between the years 1968 to 1978 changed the status of India from a food deficient country to one of the world's leading agricultural nations. There has been subsequent criticism of such intensive cultivation methods of few food crops with heavy dependence on finance towards seeds, irrigation, fertilizers and pesticides and the associated environmental and bio-diversity damage. A new vision named Evergreen Revolution was conceptualized in the first decade of the 21st century by M S Swaminathan which aims at increasing production through technology that integrates ecological principles

Photo-11: Cultivated fields in Punjab; Dr. M S Swaminathan[20]

and is environment friendly, economically viable and socially sustainable.[22]

Operation Flood - White Revolution: Similar to the food deficiency that plagued India till 1970s, the country was also deficient in milk, another critical item of nutrition, especially for child health development. The Operation Flood which led to the White Revolution was launched in 1970 by the National Dairy Development Board (NDDB) with Dr. Verghese Kurien as its Chairman. It was executed in three stages gradually linking milksheds in various cities with the consumers. That stage was financed by the sale of skimmed milk powder and butter oil gifted by the European Economic Community (EEC). At the same time the invention of the world's first spray-drier for buffalo milk by Harichand Megha Dalaya revolutionized the dairy industry. The milk movement was founded on the village milk producer's cooperatives with support for latest technology and management practices provided by NDDB. Facilities for research in healthcare and cattle feed, and their implementation were developed in parallel to ensure a robust and sustainable operation. A national network now connects producers and consumers in over 700 villages, towns, and cities ensuring fair market price and stable production. The emphasis on self-development of dairy farmers that assured regular incomes for millions in rural India makes it one of the most successful and long continuing practice in overall development of the country, winning accolades from The World Bank.[23,24]

Photo-12: Amul trinity: Verghese Kurien, Shri Tribhuvandas Kishibhai Patel, and Harichand Megha Dalaya[24]; Amul Dairy Plant at Anand, Gujarat[24]

Renewable Power: India had set up the earliest Non-conventional Energy Resources ministry in the world for renewable power in 1980s, however technological developments to support the scheme were slow. Development in wind power started in 1990s and solar power began with the launching of the Jawaharlal Nehru Solar Mission Plan in 2009 and establishment of the Solar Energy Corporation of India (SECI) in 2011. Rapid developments in both wind and solar power installations are being made with policy support from the government. However, the sore point is the near complete dependence on imported technology and equipment. Estimates for import of solar power related equipment are estimated at 22 billion USD by 2025 increasing to 42 billion USD in 2030. Indian government has set the goal of

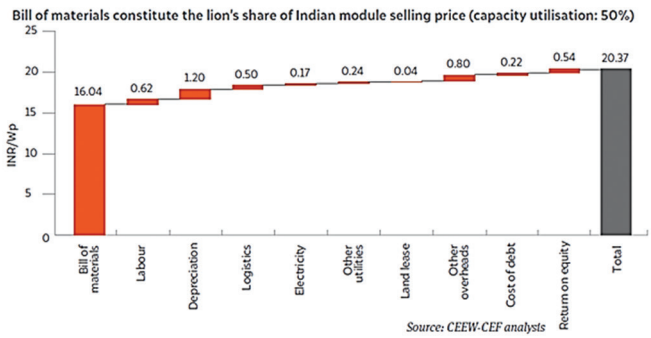

Photo-13: Materials as major share of Indian Solar Panel cost[26]

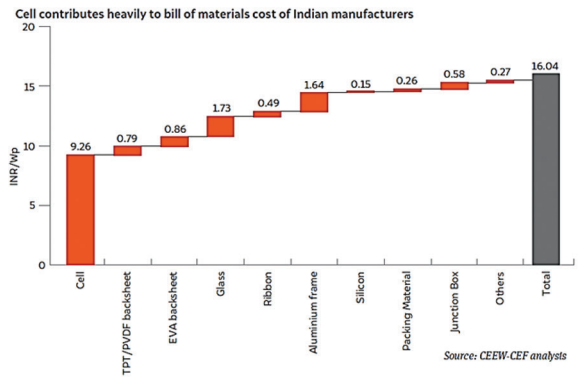

Photo-14: Major share of cells in cost of Solar panels in India[26]

achieving energy independence by 2047, coinciding with the 100th year of political independence.[25] Most of the components for manufacture of solar cells and panels are imported from China, Vietnam, Thailand and Malayasia. Panels manufactured in India are 33% higher in cost than those from China. Material cost contributes to about 56% of this difference coupled with the lower capacity utilization factor of 50%. Policy initiatives like increased customs duty on imports, production subsidy, viability gap funding over short term can help promote the indigenous manufacturing industry. Further thrust on Micro, Small, and Medium Enterprises (MSME) for sourcing of materials and indigenous R&D efforts will help develop new technologies. Long term sustainable outlook that encourages technology development and commercialization rather than unjustified protection to domestic market will help the manufacturing industry grow globally.[26]

In the case of wind power, indigenisation of up to 70% has been reached in domestic manufacturing sector. State-of-the-art technology is available in the country with major international manufacturers having set up units in India. According to the Indian Wind Energy Association the available technology can support onshore wind energy generation of 102 GW. With the focus shifting to offshore wind power generation, technological growth for bigger turbines can help the indigenous growth of this sector.

MSME sector: The Micro, Small and Medium Enterprises sector is the backbone of industrial India having 6.3 crores units that contribute to 29% of the GDP and more than 40% of exported products. The government provides support to these units for promoting rural industrialization for sustainable economy in villages and create employment opportunities.[29] It began as a loose composite of cottage industries comprising artisans and craftsmen in villages who made and marketed their products. These were organized under the Small Scale Industries (SSI) board and defined in terms of both persons employed and investment. Various units were aggregated under this board that included sectors like Khadi, Coir, Agro-based products, Ancillary units, Service enterprises and Export Oriented units. In 2007, the Ministries of Agro and Rural Industry and Small Scale Industry were merged under the Ministry of MSME. That metamorphosis has greatly transformed the rural industrial sector with policy support on technology, investment, and marketing. The call for "Atmanirbhar Bharat" is to a large extent dependent on further growth of the MSME sector. It can raise the economic prowess of masses of the country thus enabling them to be lifted out of poverty to make the large population truly self-reliant.[30]

Defence Industry: The Defence industry in India was practically non-existent prior to 1950 with only the 19 ordnance factories established by the British for manufacturing guns and ammunition. Technical developments were organized by setting up the Defence Development and Research Organization (DRDO) in 1947. The Chinese conflict in 1962 highlighted the poor condition of defence arsenal and the need to increasing weapon power. The 1965 war with Pakistan resulted in US sanctions to arms export to India and that prompted technology ties with the erstwhile Soviet Union.[33] Growth of the sector started in latter part of 20th century when targets for indigenous missile development and light combat aircraft were started. Since the 21st century, the manufacture of defence products has increased and diversified to include helicopters, submarines, torpedoes, stealth combat aircraft, and artillery shells. The opening up of the sector to private sector participation has led to great technological advancement and the country is able to produce about 50% of its defence products.[32] Defence area research and product export has also increased tremendously, and imports have reduced making self-reliance in this sector a reality.[31] Some of the successful indigenously developed defence products include Long Range Surface to Air Missile (LSRAM), Astra Beyond Visual Range Missile (BVRM), Airborne Early Warning and Control System (AEW&CS), Rustom-II Unmanned Air Vehicle, Tejas aircraft, INS Kochi and Ins Kolkata warships and Kalvari attack submarines. The Akash surface to air missile defence system is also operational.[33]

Engineering Consultancy: Engineering projects executed in India during the British period mostly comprised railways and irrigation projects. The engineering designs and construction services were

provided mostly by British and other European experts and executed by the rail companies or public works departments. Engineers from Indian colleges, notably Thomason College at Roorkee, Bengal Engineering College at Howrah and Colleges of Engineering at Pune and Guindy were recruited in PWD at low levels.[34] Few manufacturing industries that were set up before independence used expert design services from Europe and USA. The second World War created a higher demand for engineering goods and highlighted the need for growth and diversification of manufacturing industries. However, the lack of 'human capital' with adequate technical training hampered the growth of expert engineering services.[35] The thrust given to the core sector industries like power and steel after independence saw few visionaries take the bold step of forming engineering consultancy organizations – Development Consultants (an Indian unit of The Kuljian Corporation, USA) in 1950 specialized in power plants, M N Dastur specialized in steel plants. Tata-Ebasco established in 1962 as joint venture between Tata Electric and Ebasco Services USA later evolved into Tata Consulting Engineers. Engineers India Limited was established in 1965 under agreement between Government of India and Bechtel Corporation of USA to provide engineering service in oil and gas sector. Both indigenous development and technology transfer routes led to rapid growth of engineering services sector in India with more than 10,000 firms providing services in diverse sectors of industry, infrastructure, software services, and management services. The sector has seen true globalization of Indian talent having successfully executed many prestigious assignments around the world competing against world leaders and has also seen many reputed organizations setting up offices in India.[34]

Conclusions

India and its people have been a true leader of the world in the past having helped development and growth of humanity and its faculties in all aspects. India has always believed in leadership of thought rather than the ideals of exploitation and subjugation of social and natural ecosystems. Freedom of thoughts and action and openness to acceptance of diversity have been its hallmark policies that have made all who accept the concept of "Bharat" achieve self-reliance in body and spirit. It has successfully weathered many challenges from external influences through its strong roots in its own belief system and way of life. That has helped the country and its people rise time and again from adversities on their own strength.

During the growth of modern civilized society, academicians, scientists, technologists, engineers and all other professionals have played pivotal roles in reshaping the course of progress. The case studies highlighted in the foregoing sections go to show how the courage, knowledge and spirit of entrepreneurship have helped the country fashion out its own course after the colonial era. It behoves the young engineers of the day to realize the hard work that went behind these achievements in various sectors despite sanctions and restrictions imposed by technology leaders. Engineers must also realize that the purpose of desktop work is to enable creation of physical assets at site. A wholesome and sustainable design is one that incorporates the feedback from the execution at site and mitigates the multiple problems during the conversion from a virtual model to physical reality. That frees the engineers mind from overly dependent guidebook-based approach to design and help develop independent thinking to produce innovative solutions. Digital tools have made the collection, analysis and assimilation of such information more easily available at the desktop. While use of such tools is welcome, a successful engineer needs to get his "hands dirty" as part of an overall training. The engineer must continue to do that right through life. Appreciation of the challenges and the willingness to take on the new and charter unknown grounds can shape the mind to become truly "Atmanirbhar".

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07

Atmanirbharta and the Energy Transition Journey

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Director General
International Solar Alliance

Atmanirbharta is an extremely potent elixir that could catalyse the nation-building process. An atmanirbhar country not just insulates itself from external risks, but also enhances its internal capacity to offer unique value to its citizen, and to the world at large. As good as it sounds, attainment of atmanirbharta requires the patience and discipline of a monk, and the sustained hard work of a river that has chiselled rocks to create a canyon.

Over the past century, advancements in supply chain infrastructure have enabled foreign trade to flourish, making it easier to build hub-and-spoke networks and cementing interdependencies between economies. Even though this process has helped optimize costs to a large extent, it has also had an unfortunate side-effect of creating monopolies and oligopolies on a global scale. About 10%-12% of this global trade flow today is made up of fossil fuels moving from a small group of fossil fuel producing countries to consumers across the world. Given the indispensable need for energy in functioning of most economies, the power held by these producing countries creates a steep gradient not just in terms of economic advantage, but also in terms of political hegemony.

All are very familiar with the devastating effects of fossil fuel usage on the environment, but such an economic gradient also makes the consumers of fossil fuels economically dependent on its suppliers. The situation is further exacerbated by the subsidies enjoyed by fossil fuels. The International Renewable Energy Agency's (IRENA) report on energy subsidies estimated that close to USD 450 billion was spent across the world in the year 2017 to subsidise fossil fuels for end users. Availability of fossil fuels at such subsidized prices further entrenches it into the country's economy making it hard to quit.

This is a serious phenomenon in countries that are heavily dependent on fossil fuel imports, particularly the island nations and small developing states that lack the mineral resources to fuel their economic growth – the more an economy grows, the more it becomes dependent on the fossil fuel imports. This grossly oversimplified example underlines the importance of energy security when one speaks of atmanirbharta.

Renewable Energy – A Great Leveller:

In such an interconnected world, renewable energy solutions help countries use the forces of nature to meet their energy requirements. Winds blowing in from the sea towards the coasts generally hold tremendous potential to generate energy; meanwhile sunshine is another source of energy that is abundantly available in remaining parts of the world. Harnessing these renewable energy resources is the key to breaking the cycle of addiction to fossil fuels.

For countries that have so far been dependent on fossil fuel imports, renewable energy sources act as a great equaliser. With falling costs of technology, renewable energy solutions are already cheaper than fossil fuel energy across most parts of the world when the wind is blowing, and the sun is shining. During these periods, drawing power from these renewable energy sources is a no-brainer. For ensuring round-the-clock availability of renewable energy, energy storage is a key missing piece of the puzzle. Although energy storage is expensive at its current cost levels, the long-term trend pegs the falling cost of stored renewable energy to surpass the fossil fuel in energy in the coming years, levelling it with fossil fuel energy in terms of prices as well.

Even in countries where there is a gap that cannot be filled through domestic deployment of renewable energy solutions, trade of energy with immediate neighbours and regional trading partners could easily fill the gap making it much more flexible than the international trade network of fossil fuels. This is what has worked in favour of Europe where the increase in share of renewable energy supply in the electricity mix was aided by the development of strong interconnection within the EU and its neighbouring countries, including North African and Middle Eastern countries.

In the developing parts of the world, such a regional arrangement sets up a strong precedent for south-south cooperation. This cooperation would not just be limited to energy trade, but also extend to sharing of knowledge and experiences across borders.

Knowledge Sharing - The Pillar Supporting Atmanirbharta in Energy Transition

Contrary to the first impression one might build on hearing "atmanirbharta", it does not advocate a self-centred protectionist system. In fact, sharing of knowledge i.e., teaching and learning form an essential pillar that supports the building of an atmanirbhar entity. Customising renewable energy solutions to fit to local needs requires learning from similar experiences, particularly in case of developing countries. The Technology Executive Committee (TEC), the policy arm of the Technology Mechanism of United Nations Framework Convention on Climate Change (UNFCCC) has conclusively found that technologies originating from developing countries are likely to be more suitable and cost-effective for other developing countries as they are attuned to similar geoclimatic, cultural or socioeconomic conditions.

There have been multiple instances of bottom-up approaches that have used local practices, indigenous knowledge, and grass-roots initiatives from one country as the starting point for designing climate technology related interventions for multiple other countries. With the engagement of academic institutions and private sector, these could be built into strong science-backed mechanisms and lucrative business models that align technology with innovative arrangements that could be plugged-and-played across similar business environments.

That has been playing out over the past decade as India's tremendous successes in large-scale solar parks and solar water pump-based irrigations systems are being replicated across countries in South America and Africa where renewable energy deployment is being scaled up the way it was being done in India during the early 2010s. Rooftop solar installations, solar home lighting and street lighting systems are being deployed in many of these countries taking inspiration from similar installations being done by the private sector in India. Business models of mini grids deployed in Uttar Pradesh are being studied for deploying solar mini grids in the Caribbean and Pacific Island countries.

This knowledge sharing is essential for setting up foundations that would support the country's self-reliant energy ecosystem that is essential for fuelling its growth and its sustainable future.

International Solar Alliance – Pushing the Envelope for Energy Transition and Self-Reliance in Energy

The International Solar Alliance (ISA) has been striving to develop and deploy energy solutions powered by the

sun to help developing countries work towards low-carbon growth trajectories, with particular focus on delivering impact in countries categorized as Least Developed Countries (LDCs) and the Small Island Developing States (SIDS). The handholding provided by the ISA to the countries in the form of project development support and capacity building initiatives helps them build resilient systems that help them take steps towards atmanirbharta in the energy transition journey.

Since its conception on the side-lines of the 21st Climate Conference (COP21) held in Paris in 2015, ISA has welcomed 103 countries from across the world as signatories to its Framework agreement and member of the ISA. The global platform of ISA brings together multilateral development banks (MDBs), development financial institutions (DFIs), private and public sector organisations, civil society and other international institutions for delivering change in these member countries of the ISA through the solar energy technology.

During the past few years, the ISA has worked on proposals for deployment of more than 272,000 solar water pumps, close to 1,000 MW of solar rooftop installations, more than 280 MW of mini grid projects and close to 5,000 MW of solar parks. Additionally, the ISA has trained close to 1,400 professionals from around the globe, including technicians, policy makers, bankers, as well as Master Trainers who would go on to train other professionals in their respective countries.

These activities of the ISA are not just helping its members develop renewable energy projects and reduce their fossil fuel dependence, but also helping create an enabling environment that could attract investment for solar energy projects in the future without any external assistance in the form of technological dependence or financial assistance which could turn predatory. The objective is to equip countries with the know-how, the regulatory and policy mechanisms, and the market structures for making the countries atmanirbhar in their energy transition journey powered by the sun.

What Does "Net-Zero Emissions" Mean? 8 Common Questions, Answered

September 17, 2019 By Kelly Levin, Taryn Fransen, Clea Schumer and Chantal Davis Cover Image by: Aaron Minnick/WRI.

Explainer

Topic Climate Region Europe

Editor's Note: This article was updated in May 2021 to include WRI's latest research and information about new national net-zero targets.

The latest research is clear: To avoid the worst climate impacts, global greenhouse gas (GHG) emissions will need to drop by half by 2030 and reach net-zero around mid-century.

Source: https://www.wri.org/insights/net-zero-ghg-emissions-questions-answered

08

Self – Reliance in Indian Power Sector - A Path Forward

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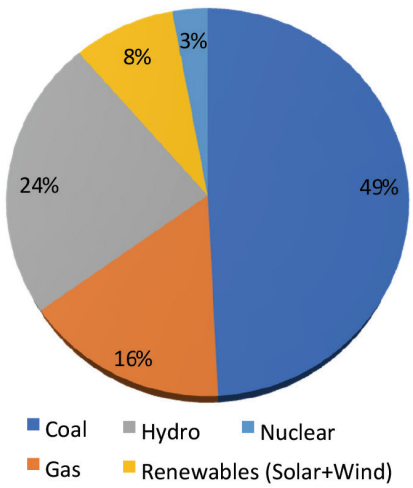
Former Chairman & Managing Director - National Thermal Power Corporation
Former MD & CEO of Jindal Power - Former MD Bajaj Power

Adequacy of economic power is most essential for the India's economic growth whether the Industrial, the Agriculture or the Services sector. As per statistics, 56% of energy is consumed in these three sectors. Thus, in regard to those sectors, the Availability, Affordability, Reliability and Efficiency (AARE) of power are most crucial parameters. AARE opens up not only sectoral growths but can also help in reducing the carbon foot prints with increase of productivity and energy efficiency. Hence in order to be **Self Reliant or Atmanirbhar** in Power it is necessary to go all out for AARE and Government policies are to be driven to meet these three crucial objectives to ensure that power remains available interruption-free and at competitive rate for the domestic users and for export market and is generated, transmitted, distributed and used efficiently. With addition of more renewable energy and new carbon free sources the subject of reliability gets more profound importance in our future road map of Power.

India is the third largest producer of power in terms of installed capacity across the globe after China and US and one of the fastest growing in renewable capacity. Let's see the capacity break up as on 31-12-2021, from Table-1 and Figures-1 and 2.

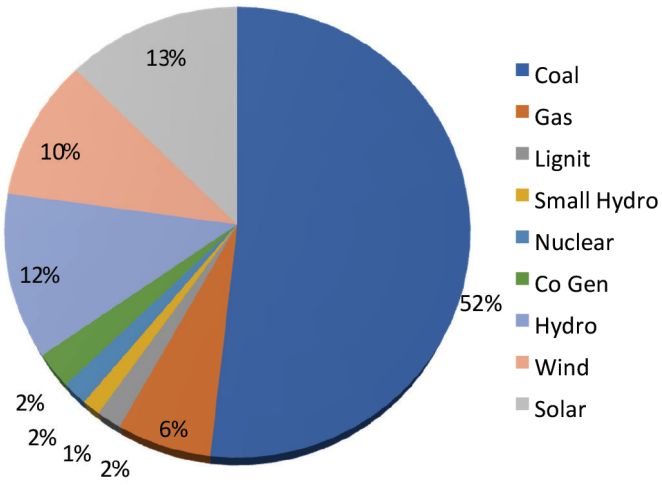
Sr. No.	Sources	Capacity in GW	% Share
1	Fossil fuel	235.0	60%
2	Non fossil fuel	151.3	40%
3	Nuclear	6.7	
4	Total	393.00	100%

Table-1: Share of the fossil fuels & non fossil fuel in India as in December 2021



Coal	Gas	Hydro	Solar	Wind	Nuclear	Total
77	24.9	36.8	0.16	13.10	4.56	159

Figure-1: Sources wise break up March-2010 (all capacities are in GW)



Coal	203
Gas	24.9
Lignite	6.62
Small Hydrogen	4.8
Nuclear	6.7
Co- Gen	10.1
Hydro	46.5
Wind	40
Solar	49.3
Total	393

Figure-2: Sources wise break up December 2021 (all capacities are in GW)

As part of its NDCs India had committed to achieving 40 % of its installed Power capacity from Non-Fossil Fuels sources by 2030. It's a proud moment for the country that the 40% target from Non fossil fuel sources has been achieved in December 2021 itself, nearly 9 years ahead. But it is also true that in terms of generation, the fossil fuels sources are contributing 75% while the non-fossil, all combined, contribute only 25%. That means there is a long way to travel to make non fossil the dominant mode of generation - rather the ratio would need to be reversed for the Net Zero Target i.e., non fossil 75% or more and fossil 25% or less.

From the above figures it can be seen that post 2010 there has been a very aggressive increase in capacity of two sources of power. One is thermal power whose capacity went up from close to 100 GW in 2010 to more than 200 GW as at present and the second is the Solar power which rose from just 160 MW i.e., 0.16 GW in 2010 to 49 GW in 2021 - a phenomenal growth. The entire scenario of self-reliance in power thus rests on these two valuable sources and their associated equipment and technologies.

To determine the factors which are would influence the self-reliance drive, there is a need to focus on the following 5 factors.

1. Fuel Availability and Supply
2. Availability of Manufactured items and their Supply Chain
3. Self-reliance for Renewable, Solar, Wind and Storage sources
4. Growth of Hydrogen as a fuel of the Future
5. Energy Efficiency

Fuel Availability and Supply

It is not ironic that India, being the third largest holder of proven coal reserves, imports around 15-20% of its coal requirement? India is dependent on import, which is highly vulnerable to price fluctuation. That can be seen from the trend in 2021 which witnessed the highest cost of coal in a decade - 146 dollar/Mt during the 3rd/4th quarter of the year. However, it stabilised at around 60 dollar/Mt for a coal of GAR 4200 kcal/kg. Unfortunately, that period also coincided with lower production of coal in India, during the same period because of the monsoons. On an average India has imported nearly 150 Mt (Million tonnes) of thermal coal in the past 5 years. Even at a cost of 60 dollar/tonne that amounts to nearly INR 67,000 crores cash outgo in foreign exchange, a huge sum.

What needs to be examined is whether it is possible to be stop coal import in toto. The answer is 'Yes', provided domestic coal mining and supply are augmented with improved technologies, automation and reduced external dependencies. Coal India Limited (CIL) is a very capable coal producer but its efforts are required to be multiplied by other players just like it happened in the Power Sector. The Power generation capacity in the country increased only when multiple players from the Private sector were allowed to add capacity and their share from just from 29 GW in 2010 jumped to around 173 GW by 2022 close to 50% of the total power generation.

The Government of India has taken a very good policy initiative and has allowed commercial coal mining by other players. It's a "land mark decision" and so far, nearly 19 coal mines have been awarded and the process is on to award more mines. That would certainly augment coal production in the country. Along with the target for making the share of renewable power to more than 60% by 2030, the country must also target for Zero import of thermal coal by 2030 for making the Indian Power sector Self Reliant in Coal supply. India should rather aim to become a net exporter of Coal.

Hence, **Atmanirbharta** in Coal by 2030 i.e., Zero import of Coal should be the agenda before the Nation along with 500 GW renewable by 2030.

Availability of Manufactured items and Supply Chain

It is seen form the past record that in the Power sector, there is a very large dependability on imported equipment and spare parts which come at a huge cost. In late 1980,s when the performance of milling system was to be improved in some plants, including extending the life of wear prone components, there were many products which were proposed by foreign manufacturers but at very high cost. Hence, they could not be procured but that paved the way for many innovations which were carried out by BHEL/indigenous manufacturers and those were used. There were many more areas in which that procedure was tried successfully. However, the plants were still dependant on imported bearings. During the period 2009-2010 the country faced acute shortage in manufacturing capacity of Boiler and Turbine equipment since BHEL was the only domestic manufacturer, with an average manufacturing capacity of 5000 - 6000 MW/annum against country's average target of adding more than 20,000 MW capacity/annum. That resulted in delays in execution due to supply chain constraints. The Ministry of Power, GOI directed the National Thermal Power Corporation (NTPC) to go for the bulk procurement of thermal units with conditions for procuring only through domestic manufactured units either by wholly owned units or JVs in which domestic Indian company had more than 51% shareholding, and with a technology transfer agreement in place. Thus nearly 4-5 companies were set up as JV by foreign companies with adequate capacity in boiler and turbine both, complying with all the conditions. BHEL also took actions to increase their capacity to around 15,000- 2,0000 MW/annum. Thus, the country became self-sufficient in the manufacturing of Boiler and TG. However, except for NTPC, who placed the order on successful domestic players, but at the same time most of the private players placed the order on Chinese companies to reduce capital cost; some players like Jindal Power and Bajaj Power were exceptions to that. That was the period when the country added more than one lakh MW thermal capacity which was mostly with imported machines. The main reason was the lower cost of imported equipment. However, some Private players bought those equipment from BHEL at quite competitive prices. That meant that right negotiation skills with sound knowledge and with right strategies the Private companies could bring BHEL to nearly similar prices as the imported ones. The imported equipment had a lot of quality issues but over a period of time that all got settled. It created another big issue with such large number of machines which were dependant on OEMs for the spares at a high cost. The moral of the story was that the domestic capacity should be cost competitive, with assured quality. Hence, any new manufacturing capabilities must be focus on the cost of production and quality to succeed.

In the Power sector, the other major equipment which are imported are Transformers, Reactors, Bushings, Control Processes and Spares for Boilers and Turbines, Generators, etc. Although these are being manufactured in India too but the Utilities still prefer to from import OEMs due to superior technologies, qualities and efficiencies and the fear of matching and fitments, etc. That is where knowledge and experience come in to be able to frame proper and correct specifications, check the manufacturing facilities and the quality control processes, negotiation skills, benchmarking of cost and strategies like strip down costing which would go to tilt the procurement in favour of the domestic players. That has been borne out by personal experience of the author, as narrated hereinafter. For a power plant, Studs for the HP and IP Control Valves of a 660 MW Unit had to be procured. Hence, OEMs were shortlisted as well as some reputed agencies who were the Sub Vendors of the

OEMs. The cost from one Sub vendor was just 20-30% of the OEM but question was "Will Sub Vendor be able to meet the quality requirement for special applications?" To get an answer to that, the Sub Vendor was asked to make a presentation of their manufacturing facilities, the heat treatment facilities and quality organisation. That was done by the Sub Vendor. Then an engineering team was also sent to verify. Some knowledgeable persons, from NTPC were also consulted. Finally, it was decided to place an order for 80% of the quantity on the Sub Vendor. The order inter alia tied up Stage testing and adherence to strict quality plans; which were drawn up in consultation with subject experts. The final product was delivered successfully and has worked as required. A similar strategy was adopted for some major equipment too.

In one plant of NTPC, there was a failure of an imported GT and the OEM was asking a large amount to repair it and that too without any guarantee. Hence, BHEL were approached to supply. BHEL did reverse engineering and manufactured the same GT for 1/3rd the cost that was being asked by the OEM. Those GTs have been in service for over 20 years now.

The learning is that a major objective should be to procure all the items especially Electrical equipment and Transmission system equipment indigenously, where the manufacturing capacity exists by proper negotiations and ensuring quality control. There are a number of manufactures in the country hence, there would be competitive bidding. However, the manufacturers would require to have an excellent quality set up to ensure the same. Necessary Policy measures to ensure products quality would go a long way to achieve that objective - spares should not be procured from abroad even for imported equipment. The two examples given above should be able to instil confidence in the Utilities in the Power sector regarding using indigenously manufactured equipment, which some Utilities may already be doing.

Another important system in a thermal power plant is the Flue Gas Desulphurisation (FGD) which has to be installed in all coal based thermal power plants. There is a tendency to import the FGD sets except by the Public Sector Units (PSUs) which have a limit of 30% for imported components. The imported components in the FGD comprise the following:

a) Absorber lining C276

b) Mist eliminators

c) Agitators

d) Spray nozzles, and

e) Vacuum belt feeders

C-276 is very costly and is available only in USA, Germany and Japan. To indigenise it, instead of C-276, rubber lining which could be very well done indigenously could be used but quality control is must. It's a question of the persons concerned, taking a call and ensuring the right implementation plan. For the latter knowledge of the product and process is essential together with the conviction that it can be done.

The other items could be indigenously developed in a planned manner. It's the tight schedule for FGD installation which has been imposed and is forcing the power plant operators to import it. As a matter of fact, the process of indigenisation should have started right in the year 2016/2017 when the mandate to install FGD was given. The country could have been self-sufficient over the years in the supply chain for FGDs; even now, the process should be started. The 30% limit is good but gradually it could be reduced and brought to Zero.

Self-Reliance for Renewables, Solar Wind and Storage Sources

All the above examples serve to show as to how vulnerable the Power sector is to Imported equipment. The country cannot afford to let the same happen in the Renewable Energy sector where capacity projection is 500 GW by 2030; it may be 1000 GW by 2050 and it may be 1500 GW by 2070. These are not wishful thinking but the real numbers to make India Net Zero by 2070. Solar, Wind and Storage sources are the future for power and may stay that way for many many centuries till other alternative sources like hydrogen-based generation and Nuclear Fusion Technology becomes feasible. Hence, it is all the more necessary that the country should work towards making the components for these systems

indigenously. India has started in right earnest and it's the duty of all in the country to make it happen.

Solar power equipment starts from the basic raw material - Polysilicon, manufacturing moves from making the ingots, to wafers, to solar cells, and finally to the solar panels. India at present has only 3 GW solar cell manufacturing capacity, and 15 GW solar modules. It is understood that India is planning to increase the capacity to 25 GW for both and also start solar wafer manufacturing capacity of 10 GW. The faster this starts, the better it will be.

At present, Polysilicon and Ingot manufacturing is dominated by China. A Solar power installation is not a onetime activity since the life is not more than 10 -12 years, hence they require to be replaced by new modules. Consequently, solar panels would be continuously required. The country should therefore move forward for manufacturing polysilicon and ingots. India has a large manufacturing capability which would need to diversify into these areas which will have a continuous market for domestic use and an export market too. Another key issue would be to track the increasing solar conversion efficiency in other countries. India will need to be a partner in the researches going on that field and update the products with new technologies on a continuous basis.

At the end it's the cost of the solar components which matters most. It's feared that the cost of solar panels would go up with indigenous manufacturing since in the solar power tariff around 50% - 60% of the cost is on account of solar panels per se, hence the tariff may go up. But that's where the challenges are and it's for the manufacturers to see how to be cost competitive. The Government of India's scheme of PLI is very good in this regard and provides some duty concessions, etc. With higher productivity the manufacturers may be able to reduce the cost impact. The Government may have to see that its fate should not go the way of the boilers and turbines where indigenous capacity went idle due to the cost factor. Close monitoring and exchange of data would be required.

Wind power has indigenous manufactures and the capacity is around 8000 - 10000 MW. Around 85-90% of the components of a wind turbine are indigenous except for large castings due to being cost competitiveness. The PLI scheme is applicable for wind turbine also.

Regarding the Storage sources, the cost of Lithium-ion battery is continuously dropping and it is going to become economically viable on a large scale. But the issue remains with high dependability on import of Lithium, cobalt, etc. Hence, India must focus on other batteries like Sodium ion and Aluminium Air battery. Sodium ion battery is almost similar to the Lithium ion one plus there is no question of import of materials for that. Many companies in the country are venturing into the sodium ion battery manufacturing, particular big companies like Reliance Industries. The Indian Oil Corporation (IOC) is working on the Aluminium Air battery. These would require to be pushed to large scale manufacturing to be cost competitive. The PLI scheme is applicable for batteries also.

On the Storage front, the country must focus on Pumped Storage Hydroelectricity schemes which are very feasible. There is a need for a thrust for Pump Hydro on the lines of the Solar and the Hydrogen missions at the Government of India's level, since unlike Batteries that will be the sources of power which would be required the most while phasing out Coal plants.

Hydrogen as a Fuel

Hydrogen is going to be the most sought after fuel in the future. Its applications will be for manufacturing, fertilizer, transport, power generation, etc., in fact all sectors and spheres of life. The Government of India has declared that India would be a Hydrogen Hub by 2047. Electrolysers are the key for hydrogen production. It's heartening that many big companies like, Reliance Industries and L&T are entering for manufacturing of Electrolysers in the country. For the hydrogen fuel to be a success the objective should be to deliver it at a cost of 1 dollar per kg or less. If that is achieved, India's path to Net Zero Emission shall become a reality much earlier than planned.

Hydrogen Powered Fuel Cells have their largest use in EV transport. Cars are being designed at a fast pace to avoid the hassle of storage battery charging while on a drive or having to swap it. Hydrogen Powered Fuel Cells are also the source for decentralised and micro grid power applications. Decentralised generation is going to be the future and hydrogen shall be a key fuel there. Hence, the country must go in a big way for manufacturing of Hydrogen Fuel Cells in India. Hydrogen can be blended with natural gas for power generation. It's use has already been proven upto 30% blending, and 100% hydrogen powered gas turbines are under development, which when hydrogen becomes available at 1 dollar/kg shall become the most dependable and flexible source of power.

Steel plants are planning to turn to hydrogen for eliminating CO_2 emission in their manufacturing. As reported, Tata Steel have plans to make green steel by 2030 by using hydrogen. A UK cement plant has demonstrated the use of hydrogen in cement kiln along with biomass, etc. and plasma energy. CO_2 from thermal power plants along with hydrogen could be captured to make value added products. NTPC is already working on a pilot project on that. The Government may have to look into Viability Gap Funding (VGF) to make it viable. If that happens it will go a long way in reduction of CO_2 from fossil fuel based plants. The big power Utilities in the Private sector must also venture into capturing CO_2 from power plants to add value to their products with cheap renewable power.

There are all chances of big demand for hydrogen in domestic and export market both and India must exploit it fully.

Hydrogen has only one drawback, and that is, it's not freely available as a product but has to be produced and there need to be proper logistics for transport and storage of hydrogen which will need to be economically viable and there are safety concerns too, and country will require to create the infrastructure with suitable policies regard to the manufacturing and usage, so that safe and economic transport infrastructure are available for meeting the demand of hydrogen for various sectors and create a right market for the same.

Hydrogen brings a great future for India to be self-reliant in Power.

Efficiency

Efficiency has been a neglected subject in the production processes in India.

Higher efficiency would mean the requirement of lower energy for the same output and consequent reduction in Green House gases. Digitalisation is the key for improvisation of efficiency across all the equipment in the Power sector. Data does give lot of information about the health of the facility but multiplicity of data needs application of data analytics for analysis and sifting to be able to use the data collected. India is the leader in the world in IT and software. Power utilities will need to collaborate with IT companies for enhancement of efficiencies and reliabilities and thus lowering of Green House gases.

Conclusions

In conclusion for India to become **Self-Reliant** i.e., **Atmanirbhar** in the Power sector the suggestions are:

i). Zero import of thermal coal

ii). Cost competitiveness and Quality Control of indigenously made components

iii). Renewed focus on Applied Research to be efficient and technologically competitive

iv). Making best use of PLI of Government of India to manufacture indigenous components for solar power, battery, electrolysers and fuel cells which should be efficient durable and cost competitive. That is the most vital out of all as the maximum installed capacity in the country will be from solar power hence manufacturing of solar components in India is crucial.

v). Adaptations of Digitalisation and Data Analytics to enhance Efficiency and Reliability

vi). Lastly, Institutional set up and framework for Quality Assurance, and continuous Research to remain in consonance with technological developments across the globe.

09

Renewable Energy Sector Marching Towards Atmanirbharta

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"For Faster growth to meet the target of $ 5 trillion economy by 2025, more supply side reforms are needed. Creating new and upgrading existing infrastructure will be key to raising India's competitiveness and achieving this target. It will specially be critical for the success of "Make in India" program as manufacturing competitiveness critically depends on infrastructure." -
National Infrastructure Pipeline *report submitted by the Task Force, Department of Economic Affairs, Ministry of Finance, Government of India.*[1]

Introduction

India has pledged its goals for decarbonization like many other countries as it's at the crossroads of an impending climate change and is taking giant steps in Energy transition by systematic infusion of clean energy sources. At COP 21, as part of its Nationally Determined Contributions (NDCs), India had committed to achieving 40% of its installed electricity capacity from Non-fossil energy sources by 2030[2]. Further, India has set an ambitious target of achieving 175 GW from Renewable sources by 2022[2]. In the recently held COP-26 summit, India has announced that it has raised its Non-fossil fuel energy target to 500 GW by 2030 and to meet 50% of its energy demand from renewable sources apart from being Net Zero by 2070.

India has achieved 40% of installed capacity from Non-fossil fuel sources in November 2021, which was a commitment made by India in COP-21 to achieve in 2030 but has achieved it 9 years in advance[3]. This shows the earnestness with which India is embracing Energy transition. As seen in Fig.1, Hydro stands at 11.9%, Nuclear at 1.7% and Renewable generation including Solar, Wind, Biomass and Small hydro has a share of 26.53% in the total installed generation capacity in the country[4]. Today, India stands 4th in the world in the overall installed Renewable energy capacity[2]. Renewable energy installed capacity has increased by 286% in last 7.5 years[2].

Non-Fossil Fuel		
RES (Incl. Hydro)	**1,51,391**	**38.5%**
Hydro	46,512	11.9%
Wind, Solar & other RE	1,04,879	26.5
Wind	40,083	10.2
Solar	49,347	12.5
BM Powewr/Cogen	10.176	2.5
Waste to Energy	434	0.1
Small Hydro Power	4,839	1.2
Nuclear	6,780	1.7
Total Non-Fossil Fuel	**1,58,171**	**40.2**
Totl Installed Capacity (Fossil Fuel & non-Fossil Fuel)	**3,93,389**	**100%**

Table-1: Split up of Non-Fossil fuel sources as on December 2021[4]

RES Category	Target Installed Capacity as on 31-03-2022	RE Sources Installed as on 31-12-2021
Solar	1,00,000	49,347
Wind	60,000	40,083
Biomass, Waste to Energy (WtE)	10,000	10,610
Small Hydro	5,000	4,839
Total	1,75,000	104879

Table-2: Renewable Energy target and status as on December 2021[4]

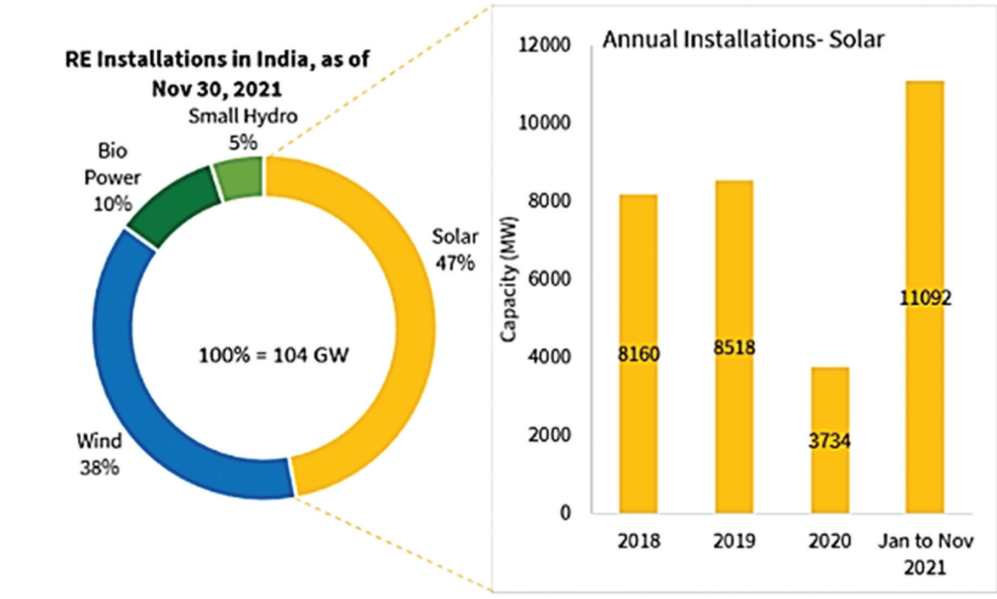

Figure-1: Composition of Renewable sources in India as of Nov 21[5]

Figure-1 shows the composition of each of the renewable sources in the overall renewable power installation in India and the annual solar additions over the last few years. As it can be seen, the share of Solar PV has been steadily increasing primarily because of introduction of favourable incentives and policies and their successful implementation apart from ensuring land certainty for Solar projects through development of solar parks.

Challenges in Achieving the Renewable Energy Target

Though it is heartening to see the rapid pace of the penetration of renewables in the overall installed capacity, the sustainability of this needs to be ensured. That pace cannot be allowed to derail because of external factors, be they economic or geopolitical. That is possible by reducing the dependency on outside sources for the key components and creating a self-sufficient supply system. That would not only help in strengthening the sector but also in generating employment opportunities for various Micro, Small and Medium Enterprises (MSMEs) throughout the supply chain. Thus, it creates opportunities for start- ups to enter the domain and also encourages innovation in every sphere in order for the enterprise to be competitive.

India's annual installed Solar Photovoltaic (PV) manufacturing capacity is approximately 3 GW for solar PV cells, 10-15 GW for solar PV modules, 5 GW for solar inverters, but no manufacturing capacity exists for "polysilicon/wafer/ingots", which is another critical component in case of solar powered systems[7]. The latter needs to be added and the others ramped up considering a proposed addition of 25 GW per year for the next 8 to 9 years to meet India's ambitious target.

India's solar exports stood at $953 million as of September 2021[6]. Figure-2 shows the trend of Solar Cell and Module import and export activity for the years 2018 to 2021. Promoting indigenous manufacturing will no doubt also save considerable foreign exchange that can be put to better use.

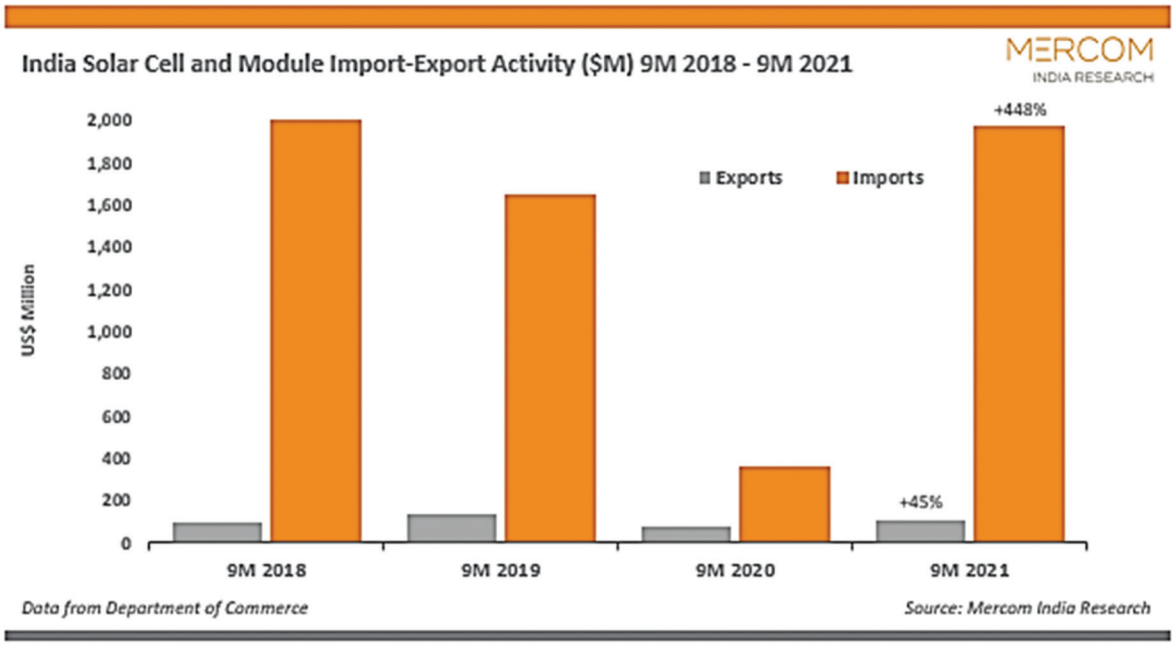

Figure-2: Status of Export and Import of Solar Cells and Modules as of Sep 2021[6]

Unlike the Solar sector which is currently heavily dependent on imports, the Wind energy sector is supported by localization of upto 80% of the wind turbine components which thus engages thousands of vendors from the MSME sector. With the proposed target of achieving 450GW by 2030 from Solar and Wind, an annual addition of about 20-25 GW of Wind for the next 8-9 years is essential. With the country's current manufacturing capacity of about 10 GW per year, more supportive policies, financial incentives and conducive bidding strategies would help not only the sector but also go to strengthening India's Atmanirbharta.

As the proportion of renewable energy in the grid increases, Energy storage systems become inevitable. Battery Energy Storage Systems (BESS) and Pumped Storage plants become good choices. BESS are heavily dependent on imports currently and in a couple of years, when storage system becomes a necessity for the stability of the grid, this dependency would not hamper the growth of the renewable sector.

Government Initiatives Towards Strengthening Atmanirbharta

As per the Vision-2025, Renewable Energy's share in the installed capacity is expected to reach 39% from the current 22%. As per the National Infrastructure Pipeline (NIP), ₹ 9.3 lakh crores investment has been envisaged for the Renewable sector.

The Production Linked Insurance scheme (PLI) scheme for solar cell and module manufacturing is aimed at pro-

Annual phasing of investments (Rs. Crore)

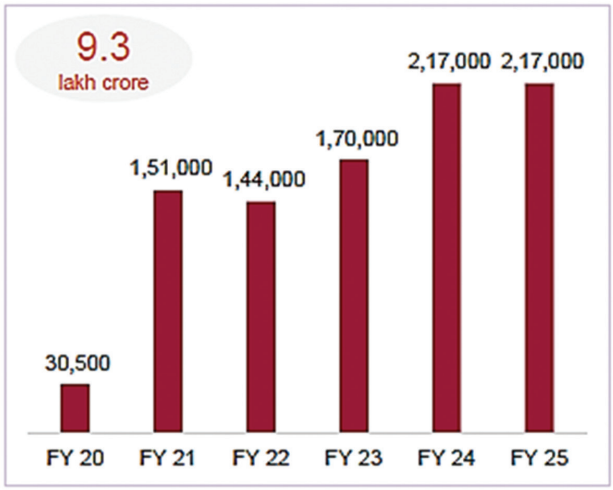

Figure-3- NIP for Renewable energy1

moting local manufacturing and the funding budgeted is ₹4500 crores. With the PLI scheme for solar PV modules (pre-budget) it is expected that 10,000 megawatts (MW) of integrated solar PV manufacturing capacity would be added and attract an approximate investment of about ₹17,200 crore along with creation of 30,000 direct jobs8. In the FY 2022-23 Budget, the Government of India has announced that to further promote domestic manufacturing, ₹19,500 crores has been added to the existing PLI scheme to support high efficiency solar PV modules for fully integrated units in 2022-23[8]. That will further increase the investment that their manufacturing sector would need to mobilize and with it there would be a multifold increase in employment generation; both of which are welcome.

The PLI tender intended to support the gigawatt-scale production of high-efficiency solar modules received bids for 54.5 GW of solar equipment annual manufacturing capacity last year (2021), with several others waitlisted[8]. Besides, imported Solar modules and cells will attract a Basic Customs Duty (BCD) of 40% and 25% respectively from 1st April 2022, which would go to boost their indigenous manufacturing, as per industry experts.

Further, distributed renewable projects will be financed in remote border villages. The Budget also encourages issue of green bonds for mobilizing the required resources for setting up green infrastructure projects in the Public sector. As an additional incentive Data Centers and Energy Storage Systems including Grid Scale Battery Storage have been brought under the umbrella of Infrastructure. This is in addition to providing duty concessions for boosting domestic manufacturing of certain electronic goods and their parts.[9]

Considering the high price of the metals in the international market, the Government of India has announced the removal of anti-dumping and countervailing duties applied to foreign-made stainless steel, coated steel products, bars of alloy steel, and high-speed steel,[8]. This will immensely benefit the solar manufacturers.

The Government also approved the Production Linked Incentive (PLI) Scheme 'National Programme on Advanced Chemistry Cell (ACC) Battery Storage' for achieving manufacturing capacity of Fifty (50) Giga Watt Hour (GWh) of ACC for enhancing India's Manufacturing Capabilities with a budgetary outlay of ₹18,100 crores[15]. Under that initiative, the emphasis of the Government is to achieve greater domestic value addition, while at the same time ensure that the levelised cost of battery manufacturing in India is globally competitive[15].

Present Status of Domestic Manufacturing

The domestic manufacturing for solar equipment is gaining traction with many companies planning for major investments. For example, Reliance Industries has announced that it would invest about $ 80 billion over the next 10-15 years to reach 100 GW of renewable including setting up of Solar PV module manufacturing via cell, module and wafers[10].

Indian PV encapsulant and back sheet manufacturer, RenewSys, brought its encapsulant production capacity up to 3GW with the commissioning of a new production line, and is eventually targeting 11GW.[10]

Early last year, Tata Power Solar Systems Ltd doubled its solar cell and module manufacturing at its facility in Bengaluru to 1.1 giga watt (GW). It has expanded its manufacturing capacity of cell from 300 MW to 530 MW with Mono PERC and that of module from 400 MW to 580 MW with Mono PERC Half cut technology[11].

Adani Solar, the solar PV manufacturing and EPC arm of the Adani group, has the largest vertically integrated company with 1.5GW of solar cell and module manufacturing facility and is among the top 15 global manufacturers[12]. Waree Energies has 2GW solar module manufacturing capacity across their plants in the country. Besides modules, they also manufacture Batteries, inverters and solar pumps[13]. Renew Power is in the process of setting up a 2GW vertically integrated solar cell and module manufacturing facility[14]. Vikram Solar has a total PV module manufacturing capacity of 2.5 GW.

Apart from these major solar module/ cell manufacturers, there are more than fifty (50) small to medium scale companies in this sector. With the additional incentives being allocated under the PLI scheme, the PV module/ cell and other component manufacturing sector will get the necessary impetus.

The PLI scheme for ACC Battery storage has been welcomed by the industry as is evident from the overwhelming response received for a 50 GWH Request for Proposal (RFP) issued under the scheme by the Ministry of Heavy Industries (MHI).

Best Practices From Other Industries

A parallel can be drawn with the PLI scheme introduced for the domestic electronics industry and possibly learn few best practices adopted by them, as this industry has shown a growth of over 187% in the last 5 years in the share of domestically manufactured electronics goods[16]. Figure-4 shows the production of electronics hardware in India over the last few years.

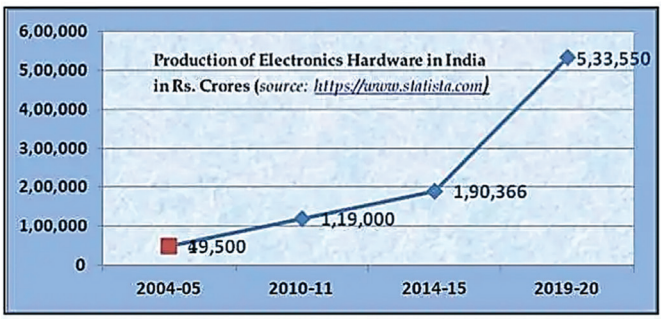

Figure-4: Production of Electronics hardware in India[16]

Vietnam has gained prominence in the electronics sector after the increase in costs in China and has attracted foreign investment in mobile phones and electronic components and many companies have set up their manufacturing in that country. With that, Vietnam's exports have jumped from $ 47.3 billion to $ 96.9 billion and it has positioned itself as one of the world's key electronic exporters. Indian solar PV cell and module manufacturing sector too can not only meet the domestic requirement but also become exporters eventually when it attains the scale and global competitiveness in the coming years.

Challenges Faced By The Domestic Manufacturing Sector

Although, the BCD imposed on the solar PV modules and cells would certainly boost the domestic manufacturing sector, there would be short-term challenges posed by increase in cost of the domestically manufactured modules until economies of scale is achieved and may also lead to delay in project execution due to supply chain issues. Hence, together the industry has to come forward to support each other and tide over the temporary but real challenges and emerge successful in the years to come. For achieving this, supportive government policies act as catalysts that promote growth and the necessary boost to the sector.

Technical competency gaps in certain specific technology driven areas and requirement of research and development in some of the critical areas are also necessary for achieving complete indigenous manufacturing. These can be catered to by having the right partnerships and attracting investments in the key areas of research and development.

Way Forward

With the present disposition, the Renewable sector is well poised to move towards Atmanirbharta. The ecosystem, strengthened by supportive government policies and initiatives is favourable and is sending the right signal not only for the Indian private sector but also to the foreign investors. The National Hydrogen Mission is also expected to boost Green Hydrogen in the country thereby

reducing fossil fuel imports and ensuring energy security, which is a major step towards being Atmanirbhar.

The following aspects can aid us further in our journey ahead:

i) Public Private Partnership in key projects and especially those which are the 'first-of-kind' projects,

ii) Academia – Industry collaboration for research and indigenous development of pilots and proto types,

iii) Adoption of state-of-the-art technologies in manufacturing using industry 4.0 standards and building indigenous competency in those areas,

iv) Widespread adoption of domestically developed products leading to increase in demand and thus their supply to help achieve economies of scale,

v) Privatisation of DISCOMS leading to autonomy and better financial health thereby agreed PPAs are honoured with better project viability and continuity of business, and

vi) Transparency in processes thereby improving ease of doing business.

The fundamental requirement for this sector, as for any other, is to conceptualise, plan and execute for the long haul in an integrated manner.

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Making India Aatmanirbhar in Infrastructure Sector

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Consulting Engineers Group Limited

Introduction

The world has witnessed the pre and post Corona pandemic scenarios and the global systems that were affected. Looking at the two periods from India's perspective, it seems that the 21st century is the century for India. At a time when the world was suffering from a deadly pandemic, India planned to convert the crisis into an opportunity by strengthening its fight by becoming Aatmanirbhar or Self-Reliant and the Aatmanirbhar Baharat campaign was announced by the Prime Minister of India, Shri Narendra Modi.

The vision is to make the country and its citizens independent and self-reliant in all senses to ensure economic freedom. That entails making all the citizens capable of gainful employment, self or otherwise, for a decent livelihood so that all rise above poverty and hunger. The income derived and/or complemented by public provisioning would ofcourse help to ensure healthy lives and wellbeing for all, of all ages, ensure inclusive and equitable quality education for all children, access to all the basic amenities for good living, and above all stem environmental degradation.

When launched, Aatmanirbhar Bharat was mainly in the context that the things which were imported before the pandemic, be manufactured in India not only for internal consumption but also for export. The Self-Reliance India mission is based on five pillars viz. Economy, which brings in quantum jump and not incremental change; Infrastructure, which should become the identity of India; System, based on 21st century technology driven arrangements; Vibrant Demography, which is India's source of energy for a Self-Reliant India; and Demand, whereby the strength of the internal demand and supply chain should be utilised to full capacity.

Economy	•To make India a USD 5 Trillion economy by 2025
Infrastructure	•Investment of more than INR 100 Lakh Crore in infrastructure development over the next 5 years
Systems	•Based on the 21st century technology driven arrangements
Demograghy	•Which will prove to be a competetive edge for a Self Reliant India
Demand	•Full utlisation of the power of demand and supply

Impact of the Mission

The Aatmanirbhar Bharat Mission has kickstarted a Self Reliance revolution in the country and is expected to be a game-changer for the Indian economy in the coming decades. Promoting the production of commodities and services in India lie at the core of the mission. Besides making India the front runner for export of goods and services, it will also generate employment for millions and boost the nation's exports. It will also help the industry develop beyond the larger cities and decentralise industrialisation. With more industries and employment opportunities in smaller towns and rural areas, people would not be forced to migrate to larger cities, thus decongestion of the big cities and leading to improvement in the quality of life, easing pressure on infrastructure, and help the environment recover. The Mission will also prepare India for any future global disruptions like the Covid-19 pandemic. However, as big and ambitious the mission is, equally humongous are the requirements to achieve it.

Infrastructure: The Aatma of an Aatmanirbhar Bharat

The Covid-19 outbreak and the subsequent lockdown took a heavy toll on the global economy. Despite having strong fundamentals and huge domestic demand, the Indian economy could not escape the impact of the pandemic as almost all the economic activities ceased during that period. However, as the nation gradually unlocked, the Government of India started taking firm steps to revive the slowing economy and the efforts have paid off.

As a step towards the Aatmanirbhar Bharat, the Indian government launched the National Investment Pipeline (NIP) where more than ₹100 lakh crore is envisaged as investment in the infrastructure sector until 2025 where since it continues to play a key role in achieving the country's economic aspirations. Sectors such as roads (about 20 % of the total investments); urban and housing (16 %), railways (14 %); conventional power (12 %); and renewable energy (9 %) account for over 70 % of the total investments.

Steps Taken by Government for the Infrastructure Sector

The Government has currently launched three stimulus packages under the Aatmanirbhar Scheme. The first stimulus package (Special Economic and Comprehensive package) of ₹20 lakh crore - equivalent to 10% of India's GDP was announced in May 2020, the second in October 2020 and the third of ₹2.65 lakh crore on November 12, 2020. The steps under Aatmanirbhar Bharat 3.0 taken to create a climate of investment and business and to boost domestic demand in the infrastructure sector are:

i. A National Infrastructure Pipeline (NIP) of ₹111 lakh crore for 6,835 investible projects in the infrastructure sector was launched in December, 2019, which is to be implemented by 2025; (increased to 7,400 projects in the Budget 2021).

ii. An equity infusion of ₹6,000 crore has been approved by the Cabinet on 25-11-2020 in the National Investment and Infrastructure Fund (NIIF) Infrastructure Debt Financing Platform, so as to enable it to attract both debt and equity investors for infrastructure.

iii. A Bill for setting up of a Development Finance Institution (DFI) to provide, enable and catalyse infrastructure financing for long-term infrastructure projects has been approved by the Union Cabinet on 16-03-2021. An amount of ₹20,000 crore has already been allocated in Budget 2021 to capitalise the institution.

iv. A "National Monetization Pipeline" of potential brownfield infrastructure assets has been announced as a financing option for new infrastructure construction.

v. To give a push to social infrastructure and to provide support to core sector infrastructure, an updated Viability Gap Funding (VGF) scheme "Scheme for Financial Support to Public Private Partnerships (PPPs) in infrastructure" has been notified in December, 2020.

vi. A ₹12,000 crore interest-free 50-year loan to given to the States for spending on capital projects.

vii Announcement of LTC cash voucher and festival advance scheme for employees.

viii. Support for the Construction Sector: relief to companies working in the infrastructure sector by reducing locking up of capital and cost of BG. Performance Security on contracts were brought down to 3% from the current industry standard of 5-10%. That was also extended to current contracts and expanded to Public Sector Enterprises. The Bid Security Declaration has replaced the current system of EMD for tenders.

ix. ₹3,000 crore released to EXIM Bank for promoting export projects through lines of credit under the IDEAS scheme

x. An additional outlay of ₹10,200 crore towards Capital and Industrial expenditure.

Challenges for implementation of the Aatmanirbhar Bharat 3.0 in the Construction Industry

It has been mentioned by the Hon'ble Finance Minister in the Budget speech that many of the measures under the Aatmanirbhar Bharat 3.0 would take up to three years to be fully established. The real challenge, as is known, lies in the grassroot level implementation of those schemes. Even though the Aatmanirbhar Bharat 3.0 aims at providing a thrust on infrastructure development, there are many unresolved fundamental and structural issues hindering the growth of the infrastructure sector. These are discussed below.

1. Dependency on Banks

Banks during the COVID period have become increasingly reluctant in lending money to infrastructure players. That has resulted in severe shortage of cash-flows and working-capital, thus putting the whole contracting ecosystem under stress. Steps should be taken by the Government to ensure that banks are more proactive while lending and do fair evaluation of the firms. Government should allow the use of Surety Bonds by insurance companies instead of PBGs that would, in turn, reduce an infrastructure firms' dependency on banks for BGs.

2. Proper Contract Enforcement

Contract enforcement remains a key challenge in construction sector. As projects are moving from Item-Rate to EPC contracts, clients are systematically transferring all project risks to contractors. That is evident from the fact that while India is continuously improving in the World Bank's 'Ease of doing business' ranking, it performs poorly on 'Enforcing contracts' parameter (163rd of 190 countries in 2020).

3. Arbitration Process

Slow arbitration process also remains a major challenge for the sector. Many project authorities do not honor NITI Aayog's guidelines of releasing 75% of arbitral award against BG. Besides, as per the original guidelines once a BG is submitted and 75% of the award amount is released, the matter is supposed to get closed in 12 months' time, if the matter is in the court. However, after withdrawal of money as per the guidelines, even after say 4 years, cases are not getting closed, thereby blocking the BG limit. The Government could consider introducing an amendment stating that within 12 months if the court has not disposed off /settled with the client, the BG needs to be released to the contractor and the amount which was released would remain in the hands of the contractor. The authorities can look at accepting a Corporate Guarantee as a security, if within 12 months the matter is not closed in the court or through amicable settlement.

4. Client Capacity Development

With increasing scale and complexity of infrastructure projects, it is observed that many clients are not upgrading their skills that are required to manage such large projects. That often results in delayed decision making and increase in project disputes. For fast implementation of projects, the government should ensure that any project above ₹5000 crores value cumulatively should be implemented by an SPV. The SPV should be only for the purpose of project implementation. Once the project is completed, the SPV could be closed.

5. Prices of Raw Materials

Another recurring challenge faced by the infrastructure sector is the steep increase in price, noticed within a span of one year, of important raw materials like cement, steel and others. Since October 2020 till date, the price of steel has increased by around 45%. That is hampering the country's growth at a time when the economy is in a revival mode, considering that steel is one of the key sectors of the manufacturing ecosystem. The issue needs to be addressed by the Government. Hon'ble Minister of Road Transport and Highways Shri Nitin Gadkari has also expressed his concern over this.

6. Removal of EMD clause

To support the infrastructure sector, the Government has removed the requirement of EMD for bidding of new tenders. While that was a welcome step, it has also negatively impacted the industry as many non-serious players have started participating in tender bidding, thus hampering bidding of projects at workable rates and prices and thus at times forcing the Government to go for rebidding. It has been seen time and again, that after getting low rates/ prices, works may not be executed due to capacity constraint of smaller contractors who win projects based on low cost. Ultimately, that mean that most of contracts would be rebid/ renegotiated and the country would lose precious time and money. All projects should incorporate requirements of bidding capacity based on net worth or cash reserves of the bidder and there should be restriction based on the number of projects which can be undertaken by any company; albeit that would vary from company to company.

Recommendations for further Boost the Aatmanirbhar Bharat in Infrastructure sector

1. Re-invigorating the Public-Private-Participation (PPP)

There is a need to review risk allocation in PPP projects to ensure a more favorable ecosystem for private players as well as financing institutions. There is a need to review the entire PPP regime so as to identify the interventions required for offering flexibility in development of new facilities and/ or upgrade the existing facilities. Suitable and attractive incentives should be provided to the private sector to invest in public utilities with a balance of risk sharing between Government and the developer.

2. Reduce Delays in Infrastructure Projects and Cost Overrun

Issues related to land acquisition, environmental clearances, rehabilitation and resettlement, removal of encroachment, accurate site data, shifting of utilities and availability of linkages to be given special focus while planning and preparing projects for being executed.

3. Accelerating Dispute Resolution

Availability of liquid finance has been significantly affected on account of large claims, disputed by the owner being stuck in litigation by way of arbitration proceedings or court cases. Delays in arbitral award and more so, inability to enforce the arbitral awards, have diminished the role of alternate dispute resolution in India. The delay added on due to the pandemic have stressed the situation further hence reforms for speeding resolution of disputes is a pressing concern.

4. Reviving the Demand Cycle

Some of the actions to revive the demand would be to fast-track award pf projects and also their implementation; clear pending bills to suppliers of goods and services by the Government, Public sector organisations and other bodies. Moving forward, the GST data should be used to track timely payment of Government dues to the industry.

5. Attract Long Term Financing for Infrastructure

Develop long-term Infrastructure bonds and also attract long term finance for Infrastructure through sovereign, insurance and pension funds. That is essential to ensure steady capital flow.

6. **Prioritize Cost Reduction**

   Prioritize Cost Reduction through Process Optimization/ Simplification.

7. **Increase Digitalisation**

   Given the time consumption and also the risks associated with physical document-based processes, complete digitalisation is critical for business continuity in the post-pandemic world. For seamless interface and end to end solution, on-boarding of all stakeholders including the authorities, financial institutions, consultants, contractors, vendors, etc. on a common digital platform is crucial. It would obviate time delays, traceability, accountability and responsibility for action to be taken and tracking of delay, etc. The benefits will be immense.

Conclusions

The thrust by the Government on Atmanirbhar Bharat and to increase investment in infrastructure development is commendable since it has strong forward-backward linkages, to shore up the economic recovery. The emphasis on providing basic necessities like highways, railways, water supply and sanitation (both in urban and rural areas) for all, power to all, housing for all, etc. will not only open opportunities for infrastructure companies, but go a long way in improving the economic activity on the ground and employment generation. However, it is imperative that Efforts should be made to ensure that these initiatives materialise in a timely fashion. The industry is optimistic that in the near future, the Government will take the required steps in resolving the challenges faced by the infrastructure industry and put the sector on a growth trajectory not only domestically but also for it to spread abroad.

Lastly, while the need for greater infrastructure investment is clear, the need to sustainably manage such investments is more important. The success of the Aatmanirbhar Bharat in the infrastructure sector be measured not by the funds invested, but by how much the sector contributes to India's economic, social and environmental objectives sustainably.

WORLD WATER DAY 2022

GROUNDWATER - MAKING THE INVISIBLE VISIBLE

Groundwater is invisible, but its impact is visible everywhere.

Out of sight, under our feet, groundwater is a hidden treasure that enriches our lives.

Almost all of the liquid freshwater in the world is groundwater.

As climate change gets worse, groundwater will become more and more critical.

We need to work together to sustainably manage this precious resource.

Groundwater may be out of sight, but it must not be out of mind.

11

Innovating our Way towards the 5-Trillion-Dollar Dream

Rajesh Mehta
President & CEO, Mehta Software Services Private Limited
Founder, Entry-India
He is a leading consultant & columnist working on
Market Entry, Innovation & Public Policy

From Aryabhata's 0 to J.C. Bose's radio technology, India has always maintained a respectable stance on the international innovation scale and been a force to reckon with. In fact, amidst our booming Silicon Valley and soaring culture of building unicorn start-ups, India is confident of emerging as an innovation superpower. The relevant question today is how to transform this advantage into economic benefits so as to realize our goal of becoming a 5-Trillion Dollar economy. After all, this is India's chance to prevent the history of missed opportunities in forms of industrial revolutions from repeating itself. Riding the global current of virtual integration, cost advantages and improved domestic innovation will have definite positive consequences for Indian economy.

From being a core service-centric economy, India has finally rerouted its focus to its formerly neglected manufacturing sector. The recent pandemic and the Russia-Ukraine war have shed light on the inherent weakness of global supply chains. Amidst this volatility, it is important to note that inefficient manufacturing, excessive global dependence can result in trade deficits. In that scenario, the reindustrialization program through the system of Government offered Production-Linked-Incentives (PLI) and heightened focus on technological evolution of MSMEs saves India from becoming a potential geo-political liability and helps it secure a more prominent role in the Global Value Chains. The government applied these PLI incentives to 14 sectors, of which telecoms, cellphones, electronic equipment and automobiles are benefiting already.

As more and more manufacturers station their Global Capability Centers (GCCs) in India, the country has not just emerged as a global base for services operations but also stands to gain from the knowledge transfers, innovation invigoration and encouraged R&D. We live in a world, where 'servicisation of manufacturing' has become increasingly common; fast-speed internet and powerful computers allow research as well as design and development of new machines, goods and consumption articles to take place anywhere in the world. The government's digital push through programs like Digital India allows us to tap these international opportunities and accelerate our economic growth. As global businesses receive rapid, at-scale and cost-effective innovation through India's cost advantages and services ecosystem; we move a step closer to the 5-trillion target.

We cannot ignore the success of Indian startup environment that has expeditiously propelled our Indian economy in the desired direction with technology at the forefront. Our Unicorn Club housed 44 new startups in 2021 with 10 more rapid additions by end February 2022. As businesses world-wide struggled to recuperate from the blows struck by the Covid-19 crisis, India transformed its challenges into opportunities and went to accelerate the growth of the start-ups in all

areas ranging from fintech to education. PAN-India digitalisation of information through the India-Stack initiative by the government transformed the fintech landscape. That has only proven that innovation, evolution and expansion go a long way in strengthening a country's economic foundation.

The sweet saga of Indian IT sector is endless, with tech consistently amplifying the wave of innovation and garnering global recognition for the past 3 decades. India's strong software industry has helped the government in executing its vision of developing the country into a digitally empowered society and move towards becoming a major superpower in the future. Attaining the goal of 5-trillion economy demands the replication of the Bengaluru Silicon Valley in potential cities of Hyderabad, Gurgaon, Noida and Pune as well. After all, technology adoption and changing consumer behaviour have opened new opportunities for young entrepreneurs to capitalize upon. Incentives need to be provided to encourage businesses abreast with technology to harness the powers of Artificial Intelligence (AI), Automation, Machine Learning (ML) and Blockchain to create innovative solutions and disrupt the conventional ways of doing business. This technology which has created a level playing field for entrepreneurs with a young and innovative mind must be correctly utilised so as to bring India's economy at par with that of tech-giant rich countries across the world. The rampant penetration of internet and smartphone in India, holds the potential for ubiquitous digitalisation across all sectors, be it healthcare, banking, agriculture, human resources or finance.

If we wish to become an IT superpower and materialise our 5-trillion goal, our banks need to have more a liberal venture capital policy. Besides, the Indian EXIM bank should give loans to software companies, which are exporting so as to quicken the move from a 'Knowledge Society' to 'Knowledge Economy'. It cannot be emphasised enough that the spirit of innovation would only come if the Government and the Companies spend more on R&D. It is unfortunate that India has a trend of a dismal <1% R&D spending, which is almost entirely borne by the government, exposing the large gap left void by the private sector. Most innovation leaders worldwide have a GDP portfolio that has at least a 2% share for R&D. For India to bring up its R&D spending to global standards, the private sector will have to step up and engage in research endeavours just like it is in Japan and the US. Not only that, every stage of an individual's development—starting from primary schooling to the workplace—must be scrutinized and revamped so as to truly harness the benefits of the large young demographic dividend. We must mobilize human capital efficiently, including the women. A growing bright, young population offers tremendous hope and positively signals those ground-breaking innovations are well within India's reach and a 5-trillion economy is not a mere dream but an achievable ambition.

12

Becoming Atmanirbhar – Concept to Reality

A P Mull
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As an Indian one is proud of the rich heritage and the vast repository of knowledge including that of science and technology that had been generated in the country although a lot of which is yet to be unearthed, understood and made known to the populace at large and thereafter be deployed for the benefit and upliftment of society to give a better quality of life to all.

One marvels at the conceptualisation, planning, design, materials, manufacturing, construction and erection methods that were used to create the magnificent structures, the materials and the machines (contrivances if one prefers that term) developed and deployed, and they have withstood the ravages of time for centuries. The ancient written texts that have been and are still being deciphered show how enlightened the people were then – they knew all about the universe, just sitting in in one place on the earth. It is because of all those discoveries that the East is referred to as the cradle of civilisation. If it could be done by the habitants of India so many centuries ago then why not by those living now? The *chalta hai, cavalier*, *lessez faire* attitude towards one's work and duties need to be replaced by one of 'can do' and 'will do' determination with a bull dog tenacity of purpose, come hell or high water. History is replete with remarkable achievements and that's the spirit and attitude that is necessary to emulate now to raise the flag of the Consulting Engineers high. The Indian Computer Science, Information Technology and Software personnel have etched India's name across the globe; the same can also be done by Indians in all other sectors of human endeavours. It would have been beneficial if those enterprising Engineers had also branched out into the other realms of not only software but also hardware and most importantly the designing and manufacturing of chips. Those steps would have been in the true spirit of *Atmanirbharta*. Becoming Self-reliant i.e., being self-capable and self-sufficient comes from thinking, evolving, acting, developing and achieving fructification of transformational concepts and goals so that they encompass all stages from start to finish and thus be in a position to lend a hand to those in need. For that holistic development in all spheres of life is necessary. However, for the paper it focuses on those which concern engineering and consulting engineering in particular.

To be Atmanirbhar, a person MUST first of all know and believe in oneself and then make oneself capable of doing what is necessary to be done. In all that one desires to do, application of the mind is a paramount necessity. For that mental and physical abilities both MUST be developed. They both are the outcome of gaining knowledge through diligent education and applying it in practice in the day-to-day life.

Humans and infact all living beings depend on the three basic essentials for life - **Air**-**Water**-**Food**. If , those can be taken care of and assured then other needs of mankind can be addressed. Now a days when one talks of technology, the inference is directly to the digital arena. As the saying goes any army cannot march on an empty stomach, so extending that logic – science, engineering and technology need to first address the unhindered availability of the three essentials mention above.

Air is everywhere, but industrialisation and consumerism

fuelled by the trend to increase financial gains have made even that extremely essential natural commodity a difficult one to be found in its unpolluted condition. It's the few humans that are misusing and mistreating what nature has provided and creating problems for the masses. Later they try to find solutions to the problems they themselves have created and the masses have to pay for that.

Water, the second most essential requirement for life is very close to the state as echoed in the lines of 'The Rime of the Ancient Mariner' - Water, water, every where, Nor any drop to drink. Just like air, fresh water is also becoming a scarcity. The unbridled expansion of urban areas and the movement of the populace to the built areas are creating major challenges for potable water supply and as a corollary for waste water as well. Solid waste management also has to be addressed wherever urbanisation starts. Newer schemes are drawn up, each bigger than the one just completed to keep supplying water to the ever expanding habitations.

Food, the third sustainer of life also needs to be brought in fully into the ambit of sustainability by employing natural ways of farming to feed the increasing population. Although the artificially produced fertilisers, pesticides, etc. have increased crop production but the effect of those on the consumers has been adverse. There is therefore a need to go back to adopting practices that do not have any adverse effects – that's where the Agricultural Engineers need to step in and provide solutions that would provide a give yield, better ways of harvesting and storage. The same applies to other forms of materials for sustenance.

The above three must thus become the main thrust areas. That's where the nature lovers, environmentalists, scientists and engineers must unite to help draw up policies which must then be enforced so that air, water and food do not become commercialised commodities. Quick-fix and half-hearted measures would get derailed. Hence, very clear-cut regulations are a MUST and they need to be strictly enforced. However, it is for the engineers to provide solutions that are in line with the 3 A's – **Appropriate**, **Adaptable** and **Affordable**, to make India Self-Reliant.

Once the above are assured, the Engineers can focus on advancing in their field. The element of trust on one and also the faith in one's own abilities for one to succeed. There will always be the need for engineers to think about the correctness of any practice and how to improve it.

For India to have that kind of resources, mere mass production of engineers is not the answer. Those that step out from the hallowed portals of an engineering institute or even a technical institute must be proficient in the 3 Rs – Reading, Writing & Arithmetic (the latter is now Mathematics), thorough in their fundamentals of physical and chemical sciences and now days even the bio-sciences, and now the ubiquitous computers. Thereafter, they must also be trained to apply the knowledge that they have gained in the courses. Acquiring a degree is just part of the process. Knowledge acquisition does not stop there – it's a life long process. With newer finds and developments – keeping pace with those in one's field is absolutely essential but it must be coupled with practical experience. The ultimate resource is the human mind, from which all else springs. Hence, it is the **Human Resource** that has to be nurtured. **Avenues for acquiring further knowledge must be provided and so also practical experience – in the office and the field to make them ready engineers.**

Once an Engineer commences to apply the knowledge gained, experience begins but with that also comes **responsibility and accountability**. There in lies the crux of all successful persons and not just engineers, but in the case of engineers the stakes are invariably high.

The Consulting Engineers Association as well as others such as the Engineering Council of India, Indian Association of Structural Engineers and Association of Consulting Civil Engineers (India) have been pursuing for decades with the Government of India for enacting **legislation for the profession of Engineering** so that its is a legally recognised profession, but above all, every **Engineer realises and performs the duty to nature and society, with full responsibility and accountability**.

The Government of India, in the interest of safety, health and well-being of the society and to prevent further degradation of the environment needs to speed up that legislation. Only then can qualified, knowledgeable, experienced and competent Engineers be sifted from the large numbers that have acquired a degree.

13

Self Sufficiency in Higher Engineering Education in India

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Abstract

Self-sufficiency in higher engineering education in India plays a significant role in meeting the socio-economic goals for the development of the country. Except IITs/IIMs/IIESTs/IISCs, the quality of graduates and post-graduates in engineering from the majority of the technical institutions in India is not up to the mark. Most of the institutions do not have sufficient qualified and trained teachers/ technicians and adequate infrastructures. Majority of the bright and meritorious students in engineering & technology leave India for higher education and research abroad due to better infrastructures, higher remuneration and due recognition of their work. The present status and quality of technical education and research institutions in India has been critically examined with a view to improve quality of the engineers coming out of their portals. The need for collaboration between educational, research and consultancy institutions in promoting quality has been emphasized.

Key Words: AICTE, Collaboration, Consultancy, Quality, Research, Technical Education

Introduction

India, with a population of 1345 million, is the largest democracy in the world. It possesses a large pool of technical manpower which is created from an annual intake of about 14,34,514 engineers for the graduate and post graduate programmes from 3,087 institutions, and 10,07,578 for the Diploma programme from 3658 institutions in engineering and technology as in 2020-21. (Table- 2.3.4 & 2.3.6 of AICTE Annual Report 2020-2021.) Zone wise distribution of intake in all types of technical education (including engineering & technology) in 9,638 institutions approved by AICTE is given in Appendix-A (AICTE Report, 2020-21), which includes 8 programmes viz. Applied Arts & Crafts, Architecture & Planning, Design, Engineering and Technology, Hotel Management and Catering, Management, MCA, and Pharmacy. The engineering educators and practicing engineers must work together and make pro-active efforts to prepare engineering education to address the technology and societal challenges and opportunities of the future (Chaturvedi, 2019). Research and development must have strong linkages with industry for meeting socio-economic goals (Mazumder, 2014, 2017a,b). University professors and the young research scholars working under the professors comprise an enormous pool of expertise and resources which must be tapped to solve many challenging problems faced by the society in the fast changing world with global competition.

This paper discusses some fundamental issues related to the quality of higher engineering education in India.

Appendix-A

Region-wise, State-wise, Level-wise no. of Institutions with Approved Intake (2020-21)

Region	State	Approved Intake			Institutions			Institution	Approved Intake
		Diploma	PG	UG	Diploma	PG	UG		
Central	Chhattisgarh	11,204	4,048	14,703	75	56	49	111	29,955
	Gujarat	57,368	22,502	55,870	156	257	196	396	1,35,740
	Madhya Pradesh	43,786	72,201	83,286	265	554	308	644	1,99,273
Central Total		**1,12,358**	**98,751**	**1,53,859**	**496**	**867**	**553**	**1,151**	**3,64,968**
Eastern	Andaman and Nicobar Islands	480	0	90	3	0	1	2	570
	Arunachal Pradesh	888	228	360	9	3	1	10	1,476
	Assam	5,430	1,924	5,585	36	33	29	68	12,939
	Jharkhand	15,222	3,143	6,710	60	26	26	86	25,075
	Manipur	210	36	150	2	1	1	3	396
	Meghalaya	370	150	630	5	2	2	7	1,150
	Mizoram	270	92	180	4	2	2	5	542
	Nagaland	525	30	180	9	1	2	12	735
	Odisha	47,684	19,111	39,393	172	195	113	316	1,06,188
	Sikkim	525	225	840	2	4	4	6	1,590
	Tripura	1,330	261	660	10	4	3	14	2,251
	West Bengal	41,690	9,820	37,720	206	134	130	302	89,230
Eastern Total		**1,14,624**	**35,020**	**92,498**	**518**	**405**	**314**	**831**	**2,42,142**
Northern	Bihar	20,045	3,227	15,706	84	47	66	164	38,978
	Uttar Pradesh	1,39,963	52,112	1,04,731	733	600	431	1,122	2,96,806
	Uttarakhand	15,797	5,670	10,648	151	76	54	187	32,115
Northern Total		**1,75,805**	**61,009**	**1,31,085**	**968**	**723**	**551**	**1,473**	**3,67,899**
North-West	Chandigarh	960	930	1,815	10	12	7	16	3,705
	Delhi	5,595	11,529	10,756	25	71	23	79	27,880
	Haryana	36,741	17,234	33,608	164	238	147	309	87,583
	Himachal Pradesh	5,000	974	3,920	34	19	27	57	9,894
	Jammu and Kashmir	5,425	1,404	3,780	36	24	12	55	10,609
	Punjab	39,384	13,665	31,642	190	207	129	309	84,691
	Rajasthan	33,810	11,629	38,771	168	165	131	313	84,210
North-West Total		**1,26,915**	**57,365**	**1,24,292**	**627**	**736**	**476**	**1,138**	**3,08,572**
South-Central	Andhra Pradesh	71,732	81,667	1,61,488	314	787	409	749	3,14,887
	Telangana	42,075	70,354	1,19,188	165	575	289	559	2,31,617
South-Central Total		**1,13,807**	**1,52,021**	**2,80,676**	**479**	**1,362**	**698**	**1,308**	**5,46,504**
Southern	Puducherry	2,392	1,463	7,683	9	17	18	27	11,538
	Tamil Nadu	1,84,371	71,671	2,68,144	501	911	547	1,243	5,24,186
Southern Total		**1,86,763**	**73,134**	**2,75,827**	**510**	**928**	**565**	**1,270**	**5,35,724**

South-West	Karnataka	81,944	51,487	1,18,204	335	486	281	743	2,51,635
	Kerala	27,281	18,626	54,370	112	253	196	353	1,00,277
South-West Total		1,09,225	70,113	1,72,574	447	739	477	1,096	3,51,912
Western	Dadra and Nagar Haveli	390	90	60	1	2	1	3	540
	Daman and Diu	660	0	300	2	0	1	3	960
	Goa	2,923	885	1,590	9	7	9	18	5,398
	Maharashtra	1,24,565	83,246	1,53,134	607	830	582	1,347	3,60,945
Western Total		**1,28,538**	**84,221**	**1,55,084**	**619**	**839**	**593**	**1,371**	**3,67,843**
Grand Total		**10,68,035**	**6,31,634**	**13,85,895**	**4,664**	**6,599**	**4,227**	**9,638**	**30,85,564**

Source: AICTE Annual Report 2020-21, Appendix 2.1

New Education Policy On Higher Education

In the New Education Policy, 2020 (https://lexlife.in/2021), a lot of focus has been laid on high quality research at the Masters and Doctoral levels. Provision has been made with three routes into the Masters' degree - a one-year degree, a two-year degree, and the integrated five-year degree. The Masters' degree will also have a strong research component to strengthen the appropriate professional competence in the domain area, and to prepare students for a research degree. A new National Research Foundation (NRF) will focus on funding research within the education system, primarily at colleges and universities. NRF will also bring cohesion among the various research endeavours of multidisciplinary character. Besides providing funding, NRF will also take care of the need to seed and build research capacity in the universities and colleges through a formal mechanism of mentoring that will be instituted. The NRF, will be responsible to:

i) bring in synergies between the stakeholders and research groups,

ii) create a mechanism for monitoring and mid-course corrections,

iii) strengthen the linkages between universities and their counterparts at global level,

iv) catalyse research in universities and colleges, institutions that have hitherto not been big players in the research scene of the country, and

v) help build the capacity to do research through an institutionalised mentoring mechanism involving expert researchers from premier institutions in the country.

Problems In Higher Engineering Education In India

A major problem being faced by the educational, research, consultancy and industrial institutions today is how to attract and retain qualified and meritorious persons (Mazumder, 2017c). A large number of such persons leave the country for higher education abroad for better pay and perks, congenial environment for research, freedom of work and above all due recognition of their achievements. Post graduate study for teaching and research is the last priority in India today. If this situation continues, then educational, research and consultancy institutions have no future and India would be dependent on foreign institutions for higher education, research and consultancy forever. There is therefore a need to deeply introspect and take appropriate measures to bring future engineers in the R&D sector at par with those from the developed countries. The gap between foreign technology and indigenous technology needs to be bridged in future so that the country becomes independent of foreign technology/ knowhow, especially since the public is interested in purchasing quality products even at higher cost.

In an earlier paper Mazumder & Mehrotra, (2019), discussed about the role of R&D in shaping future engineering professionals in India covering several aspects e.g., R&D institutions in India and the current

status of R&D in academic, research and industrial institutions in the country. The role of research publications and professional societies in advancing R&D were emphasised.

Role of Private Technical Institutions for Improving Quality

At the time of Independence, India had only a few engineering colleges engaged in undergraduate education in engineering. Since then, there has been a phenomenal growth in engineering colleges; around 90% of which belong to the private sector. Except a few, most of the private colleges have poor facilities and unqualified faculty, and most of them run only undergraduate programmes. Private engineering colleges are commercially run with the objective of making profit. There is no doubt that engineers coming out from both public and private institutions have made significant contribution for the nation's growth, but the maintaining the quality of education has become the victim of this growth phenomenon. Lack of standards for maintenance of institutions and the education imparted plus the failure to monitor the same by the regulating bodies like AICTE/ UGC is the main factor responsible for the current scenario.

Some of the factors responsible for the poor performance of the private engineering colleges are:

i. Profit is the sole criteria of private investment in education sector. Most of them were established from commercial considerations alone.

ii. Most of the private engineering colleges do not possess adequate faculty and infrastructure. Most of them are run by contractual/ guest teachers who are appointed temporarily and are not paid AICTE approved pay scales.

iii. Majority of the faculty members are old and retired faculty members from public institutions. No institute can prosper without contributions from young and energetic persons.

iv. Very few have postgraduate and PhD. level courses. Except a few, there is hardly any R&D scheme to motivate students for higher learning.

v. These colleges are affiliated to nearby universities which have little say or control in their administration and academics.

vi. Because of high fees, local students who are poor but talented and who come from nearby areas have little opportunity to enter into these colleges.

vii. Rigid and out-dated curriculum.

viii. Ineffective linkage with industry.

Mismanagement In Policy Decision

Technical education as it has developed in India has a distorted image. According to a December, 2008, report from the Indian Institute of Technology (Bombay), IITs and IISc provide only 1% graduates of the total number of students at Bachelor's level, 4% at Master's level, and 40% at PhD level. A direct consequence of this is an enormous but unfortunate growth of private coaching centres in all major cities in India where a large number of students enrol for taking IIT Entrance Test / CEE / GATE. It is not desirable to promote private coaching centres since they have no social significance, charge high coaching fees and are indirectly responsible for deterioration of the secondary and higher secondary education system in the country.

AICTE has recently closed 50% of the private engineering colleges in the country due to lack of enrolment. However, it is the same AICTE which is responsible for approving the private engineering colleges over the years and periodical evaluation of their standard. It would have been better to elevate diploma level institutes to degree level. Instead of de-recognition of the Associate Member of the Institution of Engineers (India) (AMIE) degree offered by the Institution of Engineers (India) {IEI} – a premier professional body of India established in 1920 under a Royal Charter- it would have been prudent to strengthen it by providing a linkage with nearby engineering colleges for laboratory training, etc. AMIE degree holders by and large come from economically weaker section of the society. De-recognition of the AMIE degree as equivalent to graduates from colleges has resulted in loss of opportunity for talented students belonging to

economically weaker section of our society who cannot afford paying large sum of money being charged by public/ private engineering colleges and coaching institutions. AMIE was a route through which many worthy hands in the field and industries could study and obtain a degree which would make them eligible for higher level posts. It also provided an opportunity to persons who wished to qualify/ graduate in other disciplines of engineering of his / her liking – a unique feature not available in the conventional public / private engineering institutions. The Author is well aware that many worthy engineers have contributed immensely in the growth and development of industries and institutes in India after qualifying in AMIE and later improving their qualifications by hard labour and perseverance, while working in institutes / industries.

Current Scenario of Post Graduate Education in India-Shortage of Faculty

In a report by the National Institute of Labour Economics Research and Development (NILERD,2020) submitted to AICTE, it is pointed out that "Indian higher and technical education system is one of the largest system in the world. However, an important challenge being faced by the engineering institutions across the country is the significant number of faculty vacancies and turnover, which is an important factor impeding the institutions from delivering quality education". It further states "Due to many vacancies at senior levels, that is, professor and associate professor levels, learning outcomes in these institutions have continuously been deteriorating. Strategies followed by these institutions for hiring contractual/ adhoc faculties to maintain pupil-teacher ratio as per the norms of AICTE without focusing on quality has destroyed the entire technical education system, affecting outcomes such as the placement ratio, pass-out ratio, and employability of students in most colleges".

The faculty shortage issue has been highlighted and acknowledged at the highest level in the Lok Sabha. Figure-1 indicates the faculty shortage in premier institutions like IITs. More than 50% the faculty positions remained vacant as in 2018.

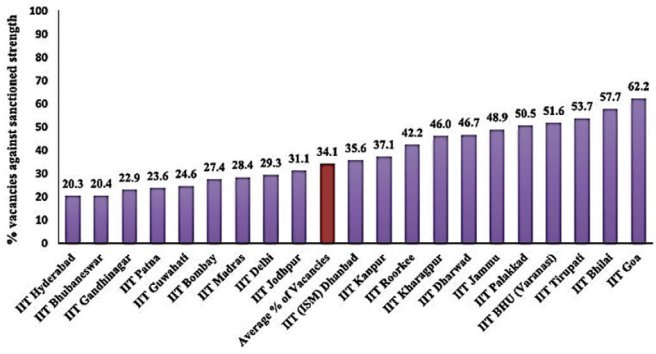

Figure-1: Faculty Vacancies (%) in IITs, as on 31st March, 2018
(Source: Lok Sabha Starred Question No. 434, dated 26 March 2018)

Dr. Manoj Varghese (2019), a senior technology, education technology & innovation leader with over two decades of international experience says "India talks a lot about the Industry readiness of its engineering graduates. Most of the experts in the higher education would bring issues such as outdated curriculum, lack of research, in adequate infrastructure and many more as the reasons for the unemployability of engineering students in India. A very few among them have noticed that, more than a curriculum or infrastructure, India faces a severe shortage of qualified faculty members. Unfortunately, being present for so many years now, faculty shortage has apparently become a permanent feature of Indian Universities".

The UN Rao (2003) Committee had also earlier pointed out that India had a huge shortage of teachers for engineering. For instance in 2000-2001, Indian engineering institutions required a Total of 60,970 teachers, the brake up of which was: 8,710 professors, 17,420 readers and 34,840 lecturers. In terms of professional qualifications, what was required were 26,130 PhDs and 34,840 M Techs. What was available however, were 5,862 PhDs and 11,035 M Tech's. That's a shortfall of around 70%, a figure that has more than doubled over the decade. So, one can imagine the quality of students passing out. With regards to the faculty shortage in Technical Institutions like IITs, the latest survey says that the nation's seven IITs need about 900 additional faculty members before the next academic

session to counteract the shortfall. However, with 27% OBC Quota and 57% increase in the seats the figures will be much higher. A string of measures - including hiring foreigners, raising the retirement age to 70, and incentive packages for new recruits have been suggested by IIT Directors, through alumni and industry networks. IITs are functioning on a 1:11 teacher-student ratio, while the ideal ratio is 1:9. Even in Delhi Universities' Delhi College of Engineering (DCE) the faculty shortage is almost 40%. The colleges also fail to meet the AICTE guidelines as per the faculty and student ratio. Far from the ideal 9 :1 for premier institutes like IITs and the 15 :1 for ordinary engineering colleges, the ration in DCE is 20:1. A shortage in teaching staff often leads to unfinished or hurried course curriculum and inadequate attention to needs of the individual student.

The shortage of quality faculty is the most serious problem confronting the Indian engineering education system. Responding to a question in the Upper House of Indian Parliament on 21st July 2015, the concerned Minister had stated that even institutions like the IITs and NITs were facing faculty shortages of about 36% and 41% respectively (The Tribune, 2014). It is a common in private engineering colleges for a person who passes and gets a BE/B.Tech degree to start teaching in the following academic year. Table-1 presents the faculty shortage in engineering institutes on national basis as mentioned by Rama Rao (2013) in his lecture at INSA.

Table 1. Shortage of Faculty (Rama Rao,2013)

Annual intake	15,00,000
Faculty required @ 1:15 ratio	1,00,000
Faculty shortage	80,000
Shortage of Master Degree holders	20,000
Shortage of Ph.D. Degree holders	60,000

Knowing that it is easy to get a job with a good salary in the IT sector, students from other disciplines concentrate more on IT related courses at the cost of their core subjects. In addition, there has been too much dependence on software packages in some of the core disciplines, leading to poor understanding of concepts and thus the ability to judge if the results are correct or not. It will not be out of place to point out that India is now a member of the Washington Accord which stipulates a minimum standard of its post graduate and PhDs. India's GDP per capita of PG is only US $ 1450 compared to a GDP of $33,400 in Japan. The number of PhDs per thousand are 7, 4 and 0.35 in Japan, USA and India respectively.

The Prime Minister terms the Indian talents going abroad is not '*brain drain but brain gain'*. However, the question remains who gains. May be the country gains monetarily from the remittances as sent by the skilled and semi-skilled workers mostly in the Middle East countries. But the most talented lot of Indians who migrate to developed countries like USA, Europe, Canada, Australia, etc. are being utilized by them to innovate, discover and develop their own institutions.

While India imports equipment and products developed by Indian origin scientists and engineers abroad, those countries are importing the best brains from India free of cost. China has understood this game very well. Most of their reputed scientists and technologists are encouraged/ inspired to return to their homeland after successful completion of studies and training abroad. Most of the Chinese institutions, are headed by eminent persons who have been educated and trained abroad; they have made phenomenal progress over the years. Talented Indians who migrate abroad continue to stay and settle there partly because of high pay and perks but mostly due to a congenial atmosphere for research & development and also due to the recognition of the work done by them.

It seems IITs are built to supply the requisite manpower for further development of the advanced countries in the world. Most of the IITans prefer joining PG/ PhD. program abroad thereby enriching foreign institutions. Unless this trend can be stemmed, India will continue to remain dependent on foreign knowhow and import foreign products/ technology at exorbitant costs. The current status of research in engineering and technology in a vast country like India can be gauged from the fact that the annual turnout of PhDs in engineering and Technology had decreased from 506 in 1979 to 374

in1996 (AICTE-1999). Although the current annual intake of PhD has now increased to 1500, the actual number who successfully complete it is much less. Approximately 400 research scholars complete their PhDs. in engineering and technology annually mainly due to lack of qualified and capable faculty. Going by the 1:2:4 ratio of cadres of professors, associate professors and assistant professors, the shortage of PhDs. in India in teaching institutions alone is estimated as 60,000 (Rama Rao,2013). Research and postgraduate education in engineering and technology is confined to only a few institutions like IITs. Despite attractive scholarships, nearly 60% of the over 19,000 sanctioned postgraduate seats (in 191 institutions) remained vacant while less than 7,000 completed the PG courses annually. Very few of IIT/ NIT students join PG courses in India; the majority of the PG students come from private/ state run colleges for getting an IIT /NIT stamp. The quality of the PG education has been discussed by the author in an earlier paper (Mazumder,2008). The low turnout and the poor quality of postgraduates who constitute the supply source of teaching and consultancy profession, is of major concern vis-à-vis the country's technical education system.

Need For Collaboration Between Educational & Research Institutions and Consultancy Organisations For Improving Quality

Research and development must have strong linkages with industry for meeting the country's socio-economic goals. Since university professors and the research scholars working under the them comprise an enormous pool of expertise and resources, appropriate collaboration must be built up between the educational and research institutions and the consultancy organisations for improving quality. The University curricula also must be upgraded to cover the emerging areas in science and technology (Madramootoo,2000). Inter-Institute collaboration between academic institutions and industries is vitally needed for improving the standard of both the educational and research institutions imparting knowledge and the practicing institutions making use of the knowledge, (Chakraborty, 1999). That can be achieved through several ways e.g. exchange of faculties, supporting research funding, carrying out research and consultancies jointly, exchange of knowledge, information and experience, participation in workshops and conferences; offering short term refresher type courses jointly with faculty drawn from both academic institution and industries, organizing training/ orientation program, taking active role in strengthening professional societies; reading journals and contributing papers in the technical journals; writing text books/ handbooks jointly; participating in the preparation of codes, manuals, guidelines, etc.

Engineers in a consultancy organization or in the field cannot keep themselves abreast with the latest research and developments except those few with an academic bent of mind. Similarly, an academic person has very little opportunity to gather practical experience, although he/ she may be equipped with the latest mathematical tools and computational techniques. Collaboration between field organizations and educational institutions will help in pooling the resources together for the most economic, efficient and time bound solution of the problems being faced in different aspects of planning, design, execution, operation and maintenance of projects. (Mazumder, Jan., 2017a). Such collaboration eventually helps in development of innovative methods and inventions, new technology, new software helping further growth of profession for the national development. All the collaborating institutions get enriched and attain a new height to face any challenge posed by the government and the society.

Considering the challenging problems being faced by India, it is of utmost importance to promote R&D in the technical & research institutions and consultancy organisations and the industries for leveraging innovations and inventions - a key to socio-economic development in a sustainable and environmentally friendly manner. Inter-institute collaboration will improve the quality of the scientists, engineers and technicians who have to be equipped with wide technical knowledge based systems integrated with work experience, creative skill and dexterity in tune with the changing socio-economic and technological scenario in the fast changing world with global competition.

Post graduate students can carry out the jobs related to the sponsored research and industrial consultancy works - a part or all of which may be included in their dissertations - both at the Master's and the Ph.D. levels. It is principally due to the contributions made by the young and energetic scholars that the department progresses and the laboratories develop. It also helps in creating quality manpower essentially required for teaching, research and consultancy jobs.

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14

Design of an Air Conditioning System for a Large Assembly Hall

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Introduction

Industrialisation is necessary for growth but it throws up challenges such as air pollution and global warming. It is therefore essential to keep the environment free of pollution at the places where people spend substantial time - residence, office, malls, supermarkets, auditoriums, theatres, hospitals, etc. Each application presents its own challenges to effectively control the internal environment so that it is comfortable and safe. For the internal air it is done by installing an Airconditioning system which enables fine control of the buildings inside environment. The inherent advantages of an airconditioned building such as control of the air Temperature and the Relative Humidity of the inside space, the Velocity of the supply air, the particulate count to maintain Cleanliness, the Oxygen level for ease of breathing, etc. are the demands which have made it an essential service in many facilities across the globe.

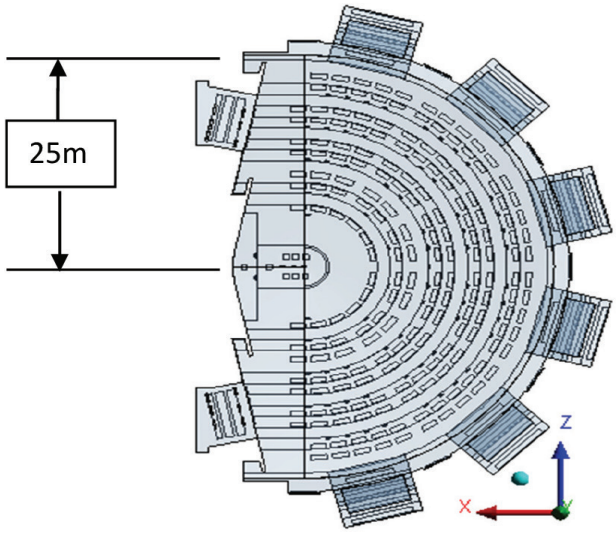
This paper shares the experience of designing of the air conditioning system for a large assembly hall to meet the shape, area, height and interior design constraints.

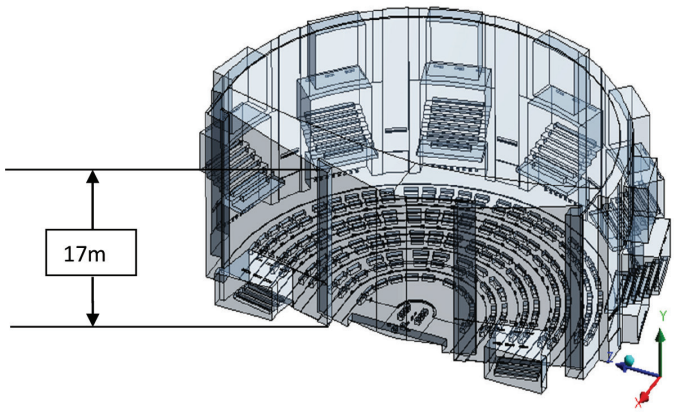
Design Challenges

The assembly hall of 1300 capacity was of Semi-circular shape, covering an area of 1486.449 sqm (16,000 sft) with a height of 17 m.

The Architectural design intent did not allow for the air supply to be done from the ceiling.

The figures show the plan and a perspective view of the Assembly Hall.





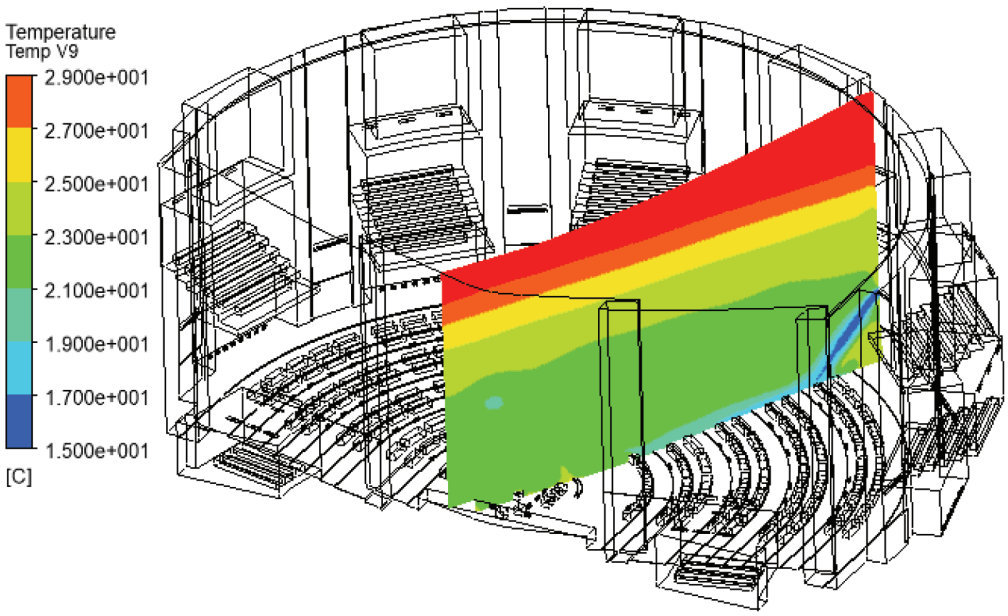
Air Distribution Philosophy for A Large Auditorium

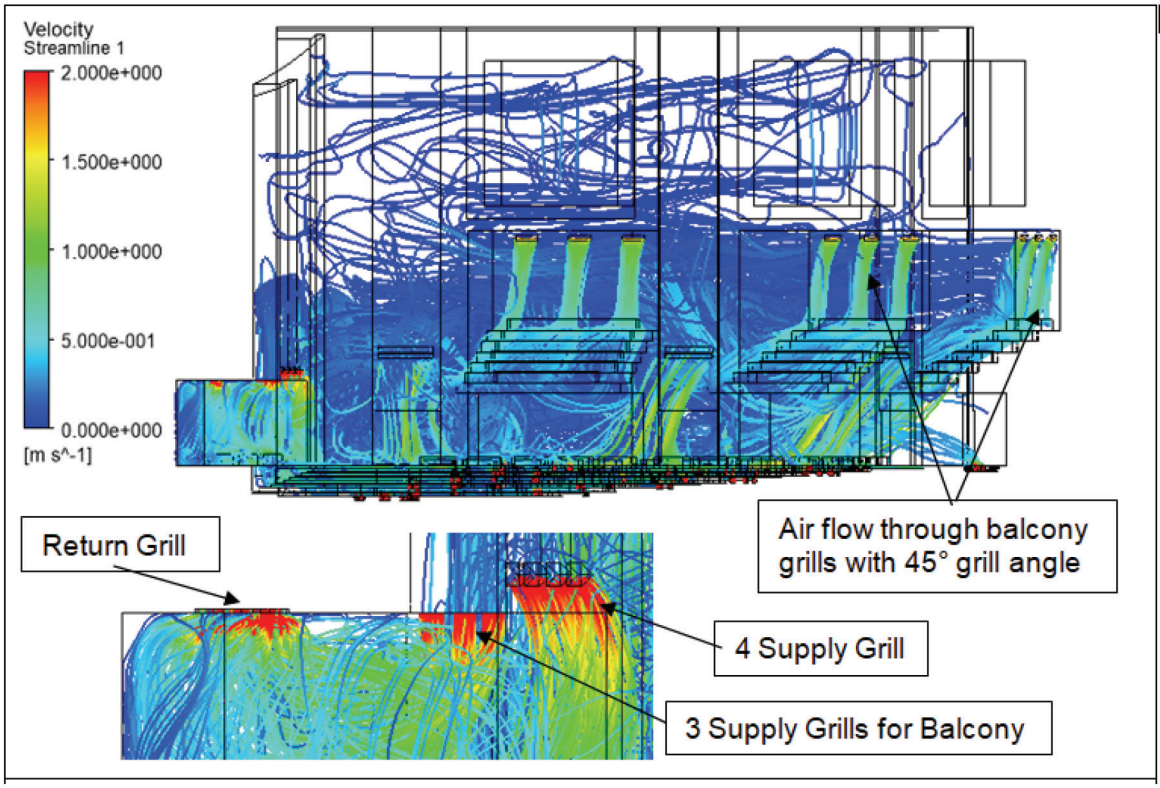
For a large Auditoriums designing of the air supply and exhaust distribution systems is always full of challenges because of the large area and height. In this case it was also semi-circular in plan with a large height and a stepped (slopping) floor. Conventionally it is easy to distribute cold supply air from ceiling and take warm return air from side or from the ceiling itself. However, in this to meet the interior design requirements, air distribution from the ceiling was not possible. Hence, an alternative was designed. It comprised seven vertical shafts to install the supply air distribution ducts and grills. The return air grills were in the suspended assembly hall floor and the ducts in the void space below that.

Thus, the treated cold air was supplied through ducts installed inside the seven vertical shafts. Two supply air grills were provided in each of the vertical shaft so as to create uniform cooling effect in the hall. They were located at height of approximately 4 – 5 m above the floor level one above the other with different throw angles. To achieve uniform cooling, strategically the lower grill was provided with 45°angle to cover nearest area and the upper grill was provided with 0°angle to cover the farthest area.

The return air was collected from the floor openings provided under few desks and led back to the AHUs through return air ducts. CAV (Constant Air Volume) boxes were used for each return air duct connection to ensure design return air always go back to the designated AHU. The use of the CAV was to help with air balancing during the commissioning stage. To compensate play or gap between individual return air opening and return air branch a flexible connection was used.

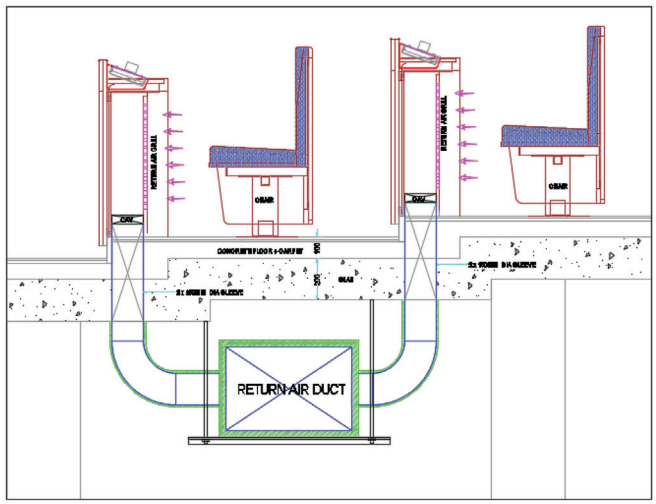
Computation Fluid Dynamics (CFD) analysis was done to check that with the arrangement as planned, uniform temperature and desired air velocity were being achieved in the respective zones being served by the different vertical shafts. CFD simulates the action of thermo-fluids in a system and is used by many industries in their development work to analyse, optimise and verify the performance of designs before the costly prototypes are made and physically tested. Based on the preliminary CFD reports the number of hot pockets were identified and corrective actions were taken i.e., increase in air flow, deploying additional AHUs for the central area, adjusting the angle of the supply grill, etc. The CFD analysis was redone after making the changes in design to check the results. The Temperature and the Velocity Profiles are shown in the figures. A typical section of the Return Air Ducts is also shown.





Conclusion

An effective air distribution system for a comfortable environmental was designed for the entire assembly hall meeting all the design requirements - large area, shape, height, and interior design aesthetics and it is functioning well.



Acknowledgement

The authors are thankful to TATA Consulting Engineers Limited for giving permission for the paper.

CEAI NEWS

FIDIC TRAINING ON "PRACTICAL USE OF FIDIC CONDITIONS OF CONTRACTS"

CEAI organized Online FIDIC Training on ***"Practical Use of FIDIC Conditions of Contracts"*** from **12th to 15th January 2022.** The event was attended by 31 engineers from various organisations. The training was conducted by Mr. Bogdan Oprea, FIDIC Accredited Trainer who covered the following topics:

Session 1: Introduction to the 1999 FIDIC documents (Construction Contract; Plant and Design-Build, Turnkey, Short Form Contract)

- Background and reasons for change
- Examination of format and content of General Conditions
- Examination of Guide to Particular Conditions
- Annex to documents
- Selection of appropriate Contract

Session 2: Responsibilities of Main Parties

- General issues
- Responsibilities of the Employer
- The Engineer
- The Contractor
- Nominated Sub-contractor

Session 3: Management of Projects - Key Areas Workmanship and Time

- Staff and Labor
- Plant, Materials and Workmanship
- Commencement, Delays and Suspension
- Tests and Defects liability

Session 4: Financial Clauses and Procedures

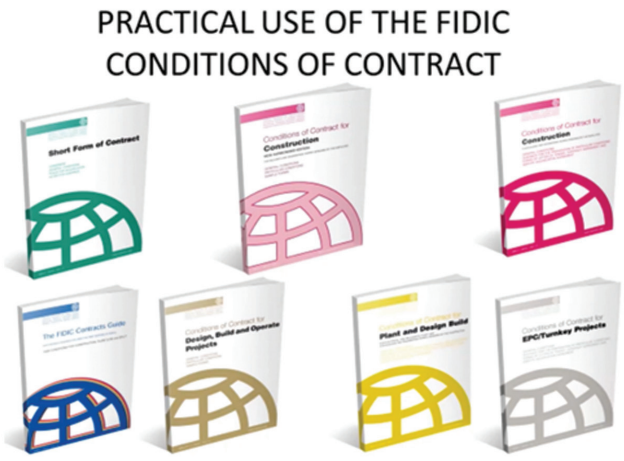
- Measurement and Evaluation,
- Variation and Adjustment
- Contract Price and Payment

Session 5: Risks, Force Majeure & Termination

- Termination by Employer
- Suspension & Termination by Contractor
- Risks and Responsibilities
- Force Majeure

Session 6: Claims Disputes & Arbitration

- Claims procedures
- Disputes Adjudication Board
- DAB Agreement & Procedures
- Amicable Settlement and Arbitration



FIDIC TRAINING ON MANAGEMENT OF CLAIMS AND DISPUTE RESOLUTION

In view to the positive feedback received from the participants on the FIDIC Training (Module I) organised in January 2022, a follow up to that to further enhance knowledge, the FIDIC Training Module II ***"Management of Claims and Dispute Resolution"*** was organized from March 2nd to March 5th, 2022.

The training was conducted by Mr. Bogdan Oprea, FIDIC Accredited Trainer who covered the following topics:

Contract

- General issues
- Contracting strategy- Balanced Contracts
- Law and the Contract

Management of Claims

- Claims Causes and Risk
- Inherent Project Risks
- Allocation of risks under various FIDIC 1999 Contracts
- Analysis of Contractual risk
- Claims procedure
- Clauses that require notice by the Contractor
- Employer's claims
- Delegation by the Engineer
- Engineer's determination
- Contractor's claims
- Notification of claims
- Engineer's assessment
- Contemporary records
- Preparation of claims
- Global Claims
- Disruption Claim

The Resolution of Disputes

- Understanding the Dispute Adjudication Boards
- History of DBs
- Engineer's decisions
- DRBs
- FIDIC DABs
- Overview of Contract Provisions
- Principles governing the DAB

Dispute avoidance vs dispute resolution

- General
- FIDIC's approach to dispute avoidance
- Disputes and their resolution

Disputes

- Definition of dispute
- Enforcement of DAB's decision
- FIDIC - the GAP

Appointment of Standing Board and Ad- hoc DAB

- The Course of the Referral
- Notice of intention to refer
- Timetable
- Submissions of the Parties
- Powers of the DAB

Post DAB Decision

- Amicable settlement
- Arbitration

Alternative Dispute Resolution Methods

- Mediation
- Negotiation
- Expert determination
- Arbitration

CEAI INTERVENTION

NEED TO CHANGE DEFINITION OF INDIAN COMPANY IN COMPANIES ACT

The Consulting Engineers Association of India (CEAI) Member has written to Prime Minister Shri Narendra Modi, regarding the need to change the definition of Indian company in the Companies Act to provide the Indian companies greater opportunities to contribute to nation building and make the country self-reliant.

MEMBER NEWS

Industry Excellence Awards 2021 to ICT Pvt Ltd

Board Member of Nangloi Water Services

Dr Ajay Pradhan, President CEAI, joined as a Board Member of Nangloi Water Services Pvt. Ltd. (NWS), a SPV of Veolia and SWACH under Delhi Jal Board. NWS operates a 40 MGD WTP catering to 1.4 million people with over 300,000 consumer connections.

Dr. Ajay Pradhan, President CEAI's paper titled ***"Building Back Better and Green Urban Infrastructure towards Smart and Resilient City"*** by has been published in **"Aspiring India @ 75 Azadi ka Amrit Mahotsav – Navigating in an uncertain world"** January 2022. The publication has been brought out by Amway India.

Another kudo for Dr. Ajay Pradhan. He has been presented a Certificate of Appreciation by his Alma Mater - The Asian Institute of Technology for his contribution to Sustainable Agriculture and Water Management.

IEI Presidents Committee

Mr. Amitabha Ghoshal, Past President CEAI has been nominated to the Council of The Institution of Engineers (India) as an Outstanding Engineer by their Presidents Committee.

Indian Achiever's Award for Mr. Amit Sharma

Mr. Amit Sharma, MD & CEO of Tata Consulting Engineers Limited (TCE), India's largest Indian private sector consulting engineering firm received the 'Indian Achiever's Award'. During COVID19, Amit demonstrated remarkable strength of character and his love for the country. He actively worked with the government to ensure that the country overcame the oxygen crisis. He led TCE to engineer Innovative out of the box timely solutions including PSA Nitrogen conversion to PSA Oxygen Plant; Modular Hospital Infrastructure; Opensource O2 Concentrator; and, CO2 & LPG Cylinder conversion for O2 Distribution.

Distinguished Alumni of IIT Madras 2022

Mr R V Chakrapani, Managing Director of Aarvee Associates awarded the Distinguish Alumni of IIT Madras, 2022.

OTHER NEWS, VIEWS & NOTES

VIEW POINT

The theme for the June 2022 issue is ***"Contract Management"***. All who are engaged in executing a contracted assignment, task, job, work, or referred to by any term need to be fully aware of and must be proficient in Contract Management so that they are always in the right. Comprehending, delineating, abiding by the requirements and thus managing from the start to the end of a contract is like finding one's way through a labyrinth of clauses in the Contract.

Professionals are invited to share their experience and know-how on managing the multi facets of Contract Management - service delivery, relationship, the contract per se, ongoing assessment, change, renewal or termination, etc. Address the challenges faced, practical issues experienced and the solutions to those, etc. Photographs, charts, diagrams, drawings, etc. would benefit readers for better appreciation of the issues encountered and the manner in which they were addressed.

The themes for the issues of ViewPoint for 2022 are given below.

Sl. No.	Theme	ViewPoint issue
1	Contract Management	June 2022
2	Tall Buildings in India (to cover all aspects from conceptualisation to end of design life)	September 2022
3	Technology/ Engineering for Sustainability and Circular Economy	December 2022

The articles for an issue need to reach CEAI at least 3 weeks prior to the end of the month of the View Point issue.

Articles need to be in Times New Roman 12 with single line spacing with before and after 6 pt and normal

margin, on A4 size. A recent clear and bright passport size photograph of the author(s) is to be sent along with the article. For details of formatting please refer to *"Format for Articles for CEAI Viewpoint"* on CEAI's website, under *'Publications'*.

Advertisement in View Point

VIEWPOINT is circulated to all CEAI Members, FIDIC, Ministries of the Government of India, Public & Private Sector Undertakings, Construction Firms, Contractors, Consultants, Foreign Missions and Funding Institutions in India and other organisations related to or dealing with the engineering profession. Thus, all stakeholders partnering development and progress are its readers.

Catch the Customers Eye

Get Wide Exposure → ***VIEWPOINT***

Improve Visibility

Support from CEAI members and stakeholders are sought for increasing the number of advertisements, so that View Point gains in its stature as a unique Technical Publication for the fraternity and the public at large to spread information of how consulting engineers are helping society for improving the quality of life and doing so sustainably.

The rates for advertisements in VIEWPOINT are given below.

Item	Rate Per issue* (Rs)	Discounted rate at 20% for 4 consecutive issues* (Rs)
Back Cover	25,000/-	80,000/-
Inside Front Cover **	15,000/-	48,000/-
Inside Back Cover **	15,000/-	48,000/-
Full Page	10,000/-	32,000/-

**GST @ 5% or as prescribed will be added to the above rates.*

**Inside Front & Back Covers booked till June 2022

Tech Quiz

1. When was the idea of Atmanirbhar Bharat put forth?
   a. 2019 b. 1420
   c. 2014 d. 1500
   e. 1645

2. What is the turnover requirement for classification as Medium in MSME?
   a. < Rs. 50 crores b. < Rs. 150 crores
   c. < Rs. 10 crores d. < Rs. 100 crores
   e. < Rs. 5 crores

3. Up to what amount will there be no Global tenders for Government tenders?
   a. Rs. 250 crores b. Rs. 150 crores
   c. Rs. 300 crores d. Rs. 100 crores
   e. Rs. 200 crores

4. What is the amount set aside for research in Union Budget for FY 2021-22 through the National Research Foundation?
   a. Rs. 50,000 crores b. Rs. 100,000 crores
   c. Rs. 25,000 crores d. Rs. 5,000 crores
   e. Rs. 10,000 crores

5. The essential for Integrated Development Planning is?
   a. Sustainability to be non-negotiable
   b. Utilise scarce resources effectively
   c. Minimise expenditure - capital & recurring, by integrating different usage areas judiciously
   d. Plan in toto so as take all the stakeholders along
   e. All the above

6. Theme for World Engineering Day 2022 was?
   a. Engineer to Build Wisely
   b. Build Back Wiser – Engineering the Future
   c. Engineer the Future - Wisely
   d. Rebuild by Engineering Wisely
   e. None of Above

7. When was a windmill first used to generate electricity?
   a. 1900 b. 1932
   c. 1887 d. 1955
   e. 1873

8. Which state has the largest Cottage Industries in India?
   a. Maharashtra b. Madhya Pradesh
   c. Tamil Nadu d. Gujarat
   e. Punjab

9. Which sector is Industry 5.0 expected to impact the most?
   a. Manufacturing b. Agriculture
   c. Construction d. Transportation
   e. Health

10. What are the Pillars of the Self-Reliant India movement?
    a. Infrastructure b. Economy
    c. Demography d. System
    e. All the above

The first person who mails the correct answers to CEAI ***info@ceai.org.in*** will get a congratulatory mail and will be acknowledged by publishing the persons photograph in the next issue..

Contributed by A P Mull

Answers to Tech Quiz December 2021 issue:
1(b), 2(d), 3(a), 4(d), 5(c), 6(b), 7(d), 8(a), 9(b), 10(c)

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- India's Longest Multi Span Extradosed Bridge across the Ganges between Ara and Chhapra in the state of Bihar .
- India's second Longest Multi Span Extradosed Bridge across the Ganges at Balia in the state of Uttar Pradesh .
- India's 2nd Longest Cable Stayed span of 350m across River Ravi at Basoli in the state of J&K.
- Building India's widest Bridge across the Ganges in the state of Bihar.
- The foundation for most of long span bridges are either large dia or Double-D shaped caisson foundations with depth as much as 60m or large dia piles with length upto 65m.

As on date SPSCPL is the only company in India to build 7 Cable Stayed / Extradosed Bridges and building another 10 Cable Stayed / Extradosed Bridges concurrently.

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Email: delhioffice@spsingla.com

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Email: spscpkl@gmail.com Website: www.spsingla.com

digitize & standardize THE CONSTRUCTION PROCESS

April 9, 2021, Friday | 3:00 to 4:30 PM IST

Daljeet Singh
Director (Works)
Delhi Metro Rail Corporation Ltd.

Andy Butterfield
MD, Global Built Environment
BSI

Nimish Gupta, FRICS
Founder & CEO
GenLeap Ecosystem

AUTODESK.
Make anything.

Building Resilient Architectural Practices

PATRICK MACLEAMY
FAIA, LEED® AP
Chairman, buildingSMART International

PHILLIP BERNSTEIN
Associate Dean and Professor Adjunct, Yale University

BIM-Based Cloud Collaboration for Roads & Highway Projects

Enabling Sustainable Building Design

V. Suresh
Chairman
IGBC

Manit Rastogi
Founding Partner
Morphogenesis

Ashish Rakheja
Managing Partner
AEON Consultants

ital Twinning of Buildin

2021, Friday
PM IST

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...your peers, share technical knowledge and...
...ctices. Don't miss it!

Speakers

Papiya Sarkar
Chief Architect
DMRC Ltd.

Ankur Mathur
Founder & CEO
Sanrachna

Sunil M. K.
Country Manager - AEC
Autodesk India & SAARC

Devansh Kakkar
Technical Specialist - AEC
Autodesk India

Chakresh Jain
Chairman
Capricot Technologies

...ll focus on leveraging the power of BIM 360 as co...
...are how you can connect teams and inform...
...cloud to improve productivity...

Compassionate Architecture

IN SEARCH OF HABITAT

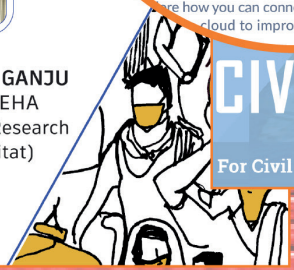
Listen LIVE

MOSHE SAFDIE
Principal,
Safdie Architects, USA

Moderated By

M.N. ASHISH GANJU
President, GREHA
(A Society for Research on Human Habitat)

5th March, 2021, Friday
6:30 PM to 7:30 PM IST



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