INAE ENGINEERS CONCLAVE 2021

October 26-27, 2021
On-line Conclave

Theme I:
Engineering challenges for de-carbonizing the Indian Economy

Theme II:
Achievements of Indian Engineering – Azadi ka Amrit Mahotsav

Jointly organized by
Indian National Academy of Engineering (INAE)
International Solar Alliance (ISA)

Technical Program
October 26-27, 2021

Day-1 – 26th October 2021 (13:00 hrs to 18:00 hrs)
1300-1345 h: Inaugural Session • **Welcome address** by Dr Ajay Mathur, DG, ISA & Co-Chair, EC -2021 • **Presidential Address** by Prof Indranil Manna, President, INAE & Co-Chair, EC- 2021 • Inaugural Address by the **Chief Guest Shri RV Shahi,** Former Secretary to the Government of India in the Ministry of Power • Vote of Thanks by Shri Pradeep Chaturvedi, FNAE
THEME-I: Engineering challenges for de-carbonizing the Indian Economy
1345-1415 h: First Plenary Talk by Lord Adair Turner, Chair, Energy Transitions Commission, UK **Topic: TBD**
1415-1430 h: Break
1430-1530 h:Technical Session-I: Energy Transitions: Integrating RE technologies in the electricity sector
Panel Discussion (45 min): Session Chair: **Shri Ajay Shankar**, Distinguished Fellow , TERI
• **Shri SK Soonee**, Advisor, POSOCO • **Dr RB Grover**, Member AEC and Emeritus Professor, HBNI and Former Vice-Chancellor, HBNI, Mumbai • **Prof Chandra Venkataraman,** IIT Bombay • **Mr Winfried Damm**, Head of Energy, GIZ-India • **Shri Mohit Bhargava,** CEO, NTPC Vidyut Vyapar Nigam (NVVN) & ED, Renewable Energy

1530-1545 h: Distinguished Address by **Prof K VijayRaghavan,** PSA to GoI

1545-1630 h: Technical Session-II: E-mobility solutions for the transport sector

Panel Discussion (45 min): Session Chair: **Shri Saurabh Kumar,** MD, Energy Efficiency Services Limited (EESL)

- **Dr Anuradda Ganesh**, Chief Technical Advisor and Director, Cummins Technical Centre India (CTCI), Pune
- **Shri Srivatsan Iyer,** Global CEO, Hero Future Energies
- **Shri S Prakash**, Distinguished Fellow, The Energy and Resources Institute (TERI)
- **Dr Anju Singh**, HoD, Environmental Engineering & Management, NITIE, Mumbai

1630-1645 h: Break

1645-1745 h: Technical Session-III: De-carbonizing heavy industry

Keynote Speaker (15 min): **Shri TV Narendran**, CEO & MD, Tata Steel

Panel Discussion (45 min): Session Chair: **Dr Ajay Mathur**, DG, ISA

- **Dr Sanak Mishra,** Immediate Past-President, INAE & Member of the Governing Board, Steel Research & Technology Mission of India (SRTMI)
- **Shri Mahendra Singhi,** CEO, Dalmia Cements (Bharat) Limited
- **Dr MO Garg,** Head – Refining & Petchem R&D, Reliance Industries Limited
- **Prof Rangan Banerjee,** Professor, Department of Energy Science and Engineering, IIT Bombay

End of Day 1 – Day 2 continued on next page

Day-2 – 27th October 2021 (13:00 hrs to 18:30 hrs)
THEME-II: Achievements of Indian Engineering – Azadi ka Amrit Mahotsav
1300-1350 h: Technical Session-I: Super/Megastructures Civil Engineering (Panel Discussion) Session Chair: **Dr Mangu Singh**, MD, Delhi Metro Rail Corporation (DMRC)
Film (5 min): **Delhi Metro Rail Corporation** (DMRC)
• **Shri Preetam Biswas,** Director, Skidmore, Owings & Merrill, New York • **Shri Srinivas Mantrala,** Vice President / Technical, Afcons Infrastructure Limited, Mumbai • **Shri Sthaladipti Saha**, Vice President & Head - Public spaces and Airports SBG, L&T
1350-1400 h: Break
1400-1450 h: Technical Session-II: Amrit moments in Chemical Engineering (Panel Discussion) **Session Chair: Shri BL Goculdas,** Managing Director and Chief Executive Officer, DMCC Ltd.
Film (5 min): **UPL**
• **Dr Ajit Sapre,** Group President - R&T, Reliance Industries Ltd. • **Dr Ajit Kumar**, Principal Technical Advisor, UPL Ltd. • **Shri Rajendra Chunodkar**, President – Manufacturing Operations, Lupin Limited
1450-1500 h: Break
1500-1550 h: Technical Session-III: Amrit moments in Electronics/ Computer Engineering (Panel Discussion) Session Chair: **Shri VVR Sastry**, Adjunct Professor, National Institute of Advanced Studies (NIAS), Bengaluru
Film (5 min): **Electronic Voting Machine** (EVM)
• **Prof Ashwin Gumaste**, Department of CSE, IIT Bombay

- **Shri RK Upadhyay**, ED & Chairman, C-Dot
- **Prof Rajat Moona**, Director, IIT Bhilai
- **Prof Surender Baswana,** Department of CSE, IIT Kanpur

1550-1600 h: **Break**

1600-1650 h: Technical Session-IV: Amrit moments in Strategic Sector (Panel Discussion)

Session Co-Chairs: **Prof AB Pandit,** Vice-President, INAE & Vice-Chancellor, ICT, Mumbai

Dr. U Kamachi Mudali, Vice-Chancellor, VIT Bhopal University

Film (5 min): **Department of Atomic Energy** (DAE)

- **Shri VK Khilnaney**, Director (Operations), Heavy Water Board, Mumbai
- **Dr AK Bhaduri**, DAE Homi Bhabha Chair & Former Distinguished Scientist & Director IGCAR
- **Dr Archana Sharma,** Group Director, Beam Technology Development Group (BTDG), BARC Mumbai
- **Shri Shyam Chetty,** Former Director, CSIR-NAL Project Director (LCA-CLAW), Bengaluru
- **Shri AS Kiran Kumar,** Former Chairman, Space Commission, Chairman, ISRO and Secretary, Dept of Space, Govt. of India

1650-1700 h: **Break**

1700-1730 h: Second Plenary Talk on *"Dilemmas at the Intersection of Scientific Temper and Engineering Ethics"* by Prof VM Naik, Department of Chemical Engineering, IIT Bombay

1730-1830 h: Valedictory Session

Chief Guest: **Dr. Shekhar C. Mande**, Secretary, DSIR & DG, CSIR

- Welcome address: **Prof. Indranil Manna**, President INAE
- Presentations by Coordinators to present deliberations and recommendations

- Valedictory Address: **Dr Shekhar C. Mande**, Secretary, DSIR & DG, CSIR
- Vote of Thanks: **Prof AB Pandit**, Vice-President, INAE

End of Engineers Conclave 2021

INAE ENGINEERS CONCLA VE 2021

Theme I:

Engineering challenges for de-carbonizing the Indian Economy

Deliberations and Recommendations

October 26, 2021

Deliberations

Theme I: Engineering challenges for de-carbonizing the Indian Economy
26th October 2021

Inaugural Session

Dr. Ajay Mathur, DG, ISA and Co-Chair, EC-2021 welcomed the Chief Guest and other Fellow Participants to the Conclave. He emphasized on energy transition with the focus on control on pollution due to fuel based emissions mainly from transport, buildings and industry sector. A collective action is required to identify energy sources and processes for tomorrow and also the engineering for this transition.

Prof. I. Manna, President, INAE, presented a comprehensive description of working of INAE and its contribution in the form of recommendations to govt. on developing strategies. INAE has supported transitional research and innovation into workable technologies in the emerging areas. The 8th Engineers' Conclave has a thrust that the economy growth should not pollute environment or degrade natural resources.

Mr. R. V. Shahi, Former Secretary, Ministry of Power, delivered the inaugural address. He emphasized that India has been adjusting its energy deficit mainly through coal based power generation and liquid fuel and gas with great dependence on import. Hydro power contribution has significantly reduced. Fossil fuel-centric power profile has changed with the introduction of sub-critical to super-critical steam based generation systems. The current emphasis on shift to the renewable energy based power generation is a bold and challenging task. The economy has to de-link from energy and emissions to make a meaningful impact. It is necessary to

focus on R&D which has largely been a neglected area for the last 50 years. There has not been any world class technological breakthrough in India. Research has to be useful and advantages to the people. Various works on new technology is important but it is equally important to identify how the existing technologies can be effectively implemented. The strategic options will obviously need to be reviewed more dynamically than in the past, considering the outcomes of various initiatives like: success of hydrogen, battery storage, low carbon use of coal including coal to hydrogen, CCU etc., and extent of change in consumption pattern through electric vehicles, railway traction etc. Though the govt. has drawn a profile upto 2040, and it seems will succeed in our effort of net zero by 2050-2060. The speed of various initiatives would depend on our success in development of affordable technologies.

Mr. Pradeep Chaturvedi, Convener, presented the vote of thanks and described how the two studies conducted by INAE during last 5 years- first on 175 GW of renewable energy by 22 and other on Clean and Green Energy in the Urban Sector have been appreciated by the Energy Committee of CAETS. He also explained that CAETS has launched the energy study based on our thrust on de-carbonization in different sectors. That shows the impact of the studies under INAE at national and international levels. Also, the Committee on SDGs Committee of CAETS has included the suggestions of INAE while developing its document after COP-6.

Theme-1: Engineering Challenges for de-carbonizing the Indian Economy

Lord Adair Turner, Chair, Energy Transitions Commission, UK delivered the keynote address: He presented a global scenario to limit 1.5 degree rise in temperature and net zero by 2050. He said the core of strategy of such a transition is

electrification to the maximum possible extent. The improvement in economics of the developing countries will result in higher and better standard of living and thereby higher electricity consumption. There is a possibility that the energy consumption in India will increase by 5-6 times and in Africa by almost about 10 times. Electricity use will increase from 25% to 60%. New capacities will be added through zero carbon route and making electricity carbon free is possible through cleaner technology.

Technical Session-1: Energy Transition – Integrating RE Technologies in the Electricity Sectors

The session was chaired by Mr. Ajay Shankar, Distinguished Fellow, TERI, following experts addressed & participated:
Mr. S. K. Soonee, Advisor, POSOCO
Dr. R. B. Grover, Member, AEC
Prof. Chandra Venkataraman, IIT Bombay
Mr. Win Fried Damm, Head of Energy, GIZ-India
Mr. Mohit Bhargava, ED-Renewable Energy, NTPC

The key points of this technical session were as follows:

1) The energy transition towards renewables and move away from fossil fuels is gathering greater momentum. This requires major reorientation in grid management by the system operator from the national level to the Distribution Company level. There is a need to manage variability of renewable generation at a macro level with regional concentration and increasing inter state flows as well as decentralised micro generation of renewables from solarised pump sets and rooftop solar power. Creative regulatory and market mechanisms would need to be crafted. Good initial work has been done and this needs to be sustained.

2) Nuclear power is a non fossil fuel energy source and can have an important role in providing an alternative to thermal power. India is well placed in nuclear power development with domestic manufacturing capacities. The key issue would be competitiveness of the tariff in the coming years vis-à-vis other sources.
3) Decentralised micro level transition from traditional use of biomass needs greater attention. This is also important for air pollution. A National Mission for Bio Waste merits consideration.
4) The price of solar power has become exceedingly attractive and is expected to go down further. A price of around Rs. 5 per unit of solar power with storage for round the clock supply is now a reality. In fact the recent long-term contracts have been finalized at a level of Rs 3.5/kWh. Building new coal power plants does not make commercial sense now.
5) NTPC is undergoing a major transformation towards renewable energy with ambitious plans.
6) There is a need to immediately accelerate the deployment of storage in the coming years to get the full benefit of the 450 GW capacity of Renewables by 2030. In fact India achieved that goal on November 19, 2021, eight years ahead of this target, a remarkable feat indeed.

Distinguished Address

Prof. K. Vijayraghavan, PSA-2 GOI delivered a distinguished address (through video recording) on e-mobility solutions for the transport sector. He mentioned that the environmental cost of disposal of e-cars should also be built into the overall costing. R&D eco-system has to be created for making the real impact. The possibility of exports of technology must be considered. Storage batteries need deeper understanding and

thrust on R&D, demonstration and production. Electronics based management has to be effectively considered and a 360 degree view need to be taken before introduction of e-mobility solutions.

Technical Session-2: E-Mobility Solutions for the Transport Sector

Following panelists participating:
Dr. Anuradda Ganesh, Chief Technical Advisor and Director, Cummins Technical Centre India (CTCI), Pune
Shri Srivatsan Iyer, Global CEO, Hero Future Energies
Shri S. Prakash, Distinguished Fellow, The Energy and Resources Institute (TERI)
Dr. Anju Singh, HoD, Environmental Engineering & Management, NITIE, Mumbai

Mr. Saurabh Kumar, MD, Energy Efficiency Services Limited, Chaired the session is as follows:

1) Decarbonisation is the need of the hour in transport sector and Green Hydrogen (GH) is not a requirement but a necessity. GHG emissions in transportation are expected to rise exponentially if urgent action is not taken.
2) Cost of GH remain the key and therefore there is a need for scaling up of RE and having decentralised generation and use of GH at the load centres.
3) GH needs more technical, research to reduce the costs. There also needs to be regulatory and policy regime to enable GH.
4) Policy landscape has to be long term with clear outcomes so that businesses may start to invest in GH and its entire value chain.
5) Batteries are key to decarbonisation and therefore their large scale deployment needs to begin at the earliest.

Regulations and policies that could reduce storage costs are critical.

6) Re-use of transportation batteries for stationary storage is needed and technical and regulatory work has to be done expeditiously.
7) A systems approach is needed where careful selection of entire value chain in a manner that it is sustainable and considers social and environmental costs.
8) The full cost of renewables must become lower than the fossil fuel based plants for fuel switching.
9) Disruption in e-mobility is waiting to happen. Stakeholders need to analyse reasons for not achieving scale in the past and fix the gaps.
10) Government needs to enable a regime that fosters innovation in technology, deployment, business models, financing at scale.
11) Financing needs of EVs needs to be addressed so that the sector gets loans at reasonable rates – this could be done by instruments like first loss guarantee funds, insurance products etc.

Technical Session-3: De-carbonizing Heavy Industries

The session was chaired by Dr. Ajay Mathur, DG, ISA

Mr. T. V. Narendran, CEO and MD, Tata Steel, delivered the keynote address. He emphasized that execution needs focus on long term goals as well as short term goals. Challenges of execution will be co-related during short-term and long term processing. Social and economic issues are crucially important while considering the carbon footprint. The selection and planning for use and energy sources is very important. Capturing blast furnace gases in industrial plant and converting into usable carbon-dioxide is very important. The industry need to change linear thinking into circular thinking. Green hydrogen needs to be produced and made available to

steel industry in sufficient quantity. While helping industry in the transition the whole process should not be over-simplified.

Following experts made presentations:
Dr. Sanak Mishra, Immediate Past President, INAE
Mr. Mahendra Singhi, CEO, Dalmia Cement (Bharat) Limited
Dr. M. O. Garg, Head – Refining and Petrochemical R&D, Reliance Industries Limited
Prof. Rangan Banerjee, IIT Bombay,

The summary of the session is as follows:

1) Steel production accounts for 7-9% of total global CO2 emissions. Steel industry has achieved significant but limited reduction in CO2 emissions over the years. Further reduction is possible only through introduction of radically new technologies. The CO2 emissions are likely to increase to 837 MT over the next 3 decades and therefore appropriate technology development is necessary. Green hydrogen is one of the options.
2) Cement industry mainly (Dalmia Industries) have reduced carbon footprint since 1990. By addressing climate- water nexus, it has become water positive group. The 2040 carbon negative road map it serving as a catalyst for the whole heavy industry sector realizing that transformation of the sector through renewable energy, hydrogen route and waste utilization will be an ideal situation.
3) De-carbonizing the refining industry is a formidable challenge of its own as this industry primarily deals with processing fossil – based carbon materials (oil and gas) to make carbon based fuels. This industry has peculiar requirements and the emissions are categorized into Scope-1, Scope-2 and Scope-3 emissions. The engineering challenges involved in handling emissions with respect to each of these scopes

are quite different. An appropriate approach will involve dovetailing the existing refinery units with petrochemicals production units.

4) Energy transition calls for industry benchmarking, efficiency improvement, larger renewable applications, carbon capture and utilization and process changes, and also the need for policy thrust on technology demonstration and R&D and low carbon industrial process. The short term measures are as important as the long term measures.

Recommendations

Theme I: Engineering challenges for de-carbonizing the Indian Economy

26th October 2021

1. **In its move to net zero by 2070 (as announced by the Hon'ble PM at COP26, Glasgow, though in the Conclave the year mentioned was 2050) India needs to transform to a non-fossil fuel economy. This requires utilization of cleaner coal technologies, nuclear power, solar and batteries.**

   Various countries will have to follow carbon neutral energy trajectory. A large number of country are still not on the path of controlling temperature rise within 1.5°C by 2050. At the same time the energy consumption is likely to increase by 5 to 10 times, thereby making the options more difficult. India's commitment to reach a target of 500 GW of renewable energy power by 2030 is challenging and requires a number of actions for an orderly transition. Countries like India that are endowed with large domestic resource of coal and largely dependent on import of oil and gas will like to continue its thermal power plant for their life time. This will call for cleaner technologies for coal preparation and conversion; and greater emissions control. Nuclear Power has to be developed as an option for base load power as it is carbon free. Small and medium nuclear

plants need to be promoted on affordable technologies. Batteries are key to de-carbonization. Therefore, their large scale deployment needs to begin at the earliest. The recent news item clearly indicates India's success. It has achieved the target of 500 GW of renewable energy on November 19, 2021, full eight years ahead of the target. This needs to be sustained, as a significant contribution has come from hydropower, which is still monsoon dependent.

2. **Directed technology research and development starting now is essential to meet the goals of the energy transition.**

Enabling reformulation of energy strategy is necessary for significantly higher attention than in the past, as technology research and development in India has not shown results in terms of breakthrough technology development. Technology research focused on hydrogen as fuel, and hydrogen fuel cell to generate power needs be fast tracked. Program on clean carbon coal technologies along with CCU is important. De-carbonization of the transport sector and the industry must be considered through the green hydrogen route. The cost of production of green hydrogen remains the key. Innovation and technology development will include an important component of technology demonstration and assimilation. Both have long gestation periods, which should be appropriately factored in technology deployment.

3. **The electricity sector transition to renewable sources requires major re-orientation in grid management by the system operator from the national level to the distribution company level.**

4. **The transport sector requires interventions to enable a move towards the use of battery power, hydrogen, and renewable-based electricity.**

   E-mobility solutions for the transport sector will be a major step towards carbon neutral environment. R&D eco-system has to be created for making the real impact. The possibility of export of technologies must be built into the redevelopment program. Railways have already established transition to electric power as a goal.

5. **In the industrial sector, most low temperature applications can be converted to electric heating, powered by renewable electricity. For higher temperature applications, hydrogen fuels, produced by the splitting of water using green electricity, could be a possible solution.**

   The use of hydrogen in steel production is already being developed. The steel industry has achieved limited reduction in CO_2 emissions over the years. Further reduction is possible only through introduction of radically new technologies. Cement industry has also witnessed reduced carbon footprint by addressing climate-water nexus. Renewable energy use, and green

hydrogen and waste utilization will play important role. De-carbonizing refining industry is a formidable challenge as they deal with processing fossil based carbon material to make carbon based fuels. Appropriate dovetailing the existing refinery units with petrochemicals units is desirable.

6. **Energy transition calls for industry benchmarking, efficiency improvement and large renewable applications. Short-term measures are as important as long term measures. Recycling is an important immediate measure.**

System approach is needed where careful selection of entire value chain is sustainable and considers social and environmental cost. In all sectors, enhanced recycling is essential in order to reduce the demand for virgin raw material.

7. **Government needs to focus on various issues that can broadly be categorized as: (i) Physical Building Blocks; (ii) Economic and Societal Adjustment; (iii) Governance, Institutions and Commitment.**

Physical building blocks will include: (i) Technological innovation; (ii) Ability to create at-scale supply chain and support infrastructure; and (iii) Availability of natural resources. Economic and Societal Adjustment will include: (i) Effective capital reallocation and financial structures; (ii) Management of demand shifts and near-term unit cost increase; and

(iii) Compensating mechanism that addresses socio-economic impact. Governance, Institutions and Commitment will include: (i) Governing standards, tracking and market mechanisms and effective institutions; (ii) Commitment by and collaboration among public, private and social sector leaders globally; and (iii) Support from citizens and consumers.

8. Innovation and technology development will include an important component of technology demonstration and assimilation. Both have long gestation periods, which should be appropriately factored in technology deployment.

9. For all non-fossil fuel applications, capital cost predominates (since there are very low operating costs). Consequently, it is important to bring down the cost of capital.

INAE ENGINEERS CONCLA VE 2021

Theme II:

Achievements of Indian Engineering – Azadi ka Amrit Mahotsav

Deliberations and Recommendations

October 27, 2021

Deliberations

Theme II: Achievements of Indian Engineering – Azadi ka Amrit Mahotsav
October 27, 2021

These deliberations were on achievements of Indian Engineering – Azadi ka Amrit moments of Indian Engineering.

Technical Sessions: It had four technical sessions.

1.1) Technical Session-I: Super/Megastructures Civil Engineering (Panel Discussion)

1.2) Technical Session-II: Amrit moments in Chemical Engineering (Panel Discussion)

1.3) Technical Session-III: Amrit moments in Electronics/ Computer Engineering (Panel Discussion)

1.4) Technical Session-IV: Amrit moments in Strategic Sector (Panel Discussion)

2) Plenary talk: After the four technical sessions there was a Plenary talk on "Dilemmas at the Intersection of Scientific Temper and *Engineering Ethics"*

3) Valedictory Session: At the end there was a Valedictory Session

Technical Sessions:

1.1) Technical Session-I: Super/Megastructures Civil Engineering (Panel Discussion)

This session was on super/ megastructures in civil engineering and covered the following talks:

I. Magnificent Airport Structures - A Story of True Architectural-Engineering (AE) Integration

II. Chenab Bridge- Engineering marvel in making

III. "Tallest, Strongest, Fastest" – The Statue of Unity.

The Session was chaired by Dr Mangu Singh, Managing Director, Delhi Metro Rail Corporation Ltd.

Talk I: Magnificent Airport Structures - A Story of True Architectural-Engineering (AE) Integration.

The talk was delivered by Shri Preetam Biswas, Director, Skidmore, Owings & Merrill, New York on "Magnificent Airport Structures - A Story of true AE Integration". The Mumbai International Airport serves as the modern day 'Gateway of India' along with Delhi, for most international travellers coming into India. It is the first impression of resurgent India. Image and context is thus, a vital part of the design but so is its functionality and operation. The hugely complex functionality of a large airport is best served by a truly integrated Architectural-Engineering (AE) approach to its design and implementation. It starts with a building grid system that caters to various typologies of aircrafts and accommodates miles of baggage belts and intricacies of the entire baggage handling system. A building structure that allows the smooth functioning of an airport today needs to be simultaneously agile and adaptable to future changes in operations, which is about the only certainty in an Airport. Sometimes, the complexity of its function can be rivalled only by the ingenuity of the methodology implemented in its construction and hence a constructability-focused design lends itself best to the overall success of the project. What a traveller experiences is only a portion of the larger story. Understanding what design and engineering decisions were taken during the project conceptualization and construction, and its impact will provide a clarity of purpose for the Mumbai International

Airport. The story of sustainability and reduction in the embodied carbon footprint as a design catalyst will make for better appreciation of the upcoming Terminal in the Bengaluru International Airport termed as 'The Airport in the Garden' for the Garden City of India.

Shri Biswas highlighted that the major challenge while constructing the Chhatrapati Shivaji Maharaj International Airport, Mumbai was to capture the spirit of Mumbai and essence of India. The Challenging aspects of airport structures were complex planning with site constraints, Special building systems-baggage, security etc., scale and span, phasing, sustainability goals and local materials and expertise. Another major challenge was heavy rainfall in Mumbai and this challenge was overcome by building single roof over multiple buildings.

Talk II: Chenab Bridge – Engineering Marvel in the Making

The talk was on the "The Chenab bridge- Marvel in the making" delivered by Shri Srinivas Mantrala, Vice President/ Technical, Afcons Infrastructure Limited, Mumbai. The Chenab Bridge is a very important component of the Udhampur - Srinagar- Baramulla Rail Link Project. When completed, the bridge will span the Chenab River at a height of 359 m above the river, making it the world's highest railway bridge. The design life is 120 years. The major challenges were active young mountains, subzero temperature, difficult to access and sensitive border area. The talk focused on details of Chenab Bridge, current status, Arch Erection. The balance work on hand and a glimpse of the micro details of the project in terms of construction tolerances were highlighted.

Talk III: "Tallest, Strongest, Fastest" – The Statue of Unity

The talk was delivered by Shri Sthaladipti Saha, Vice President&Head - Public spaces and Airports SBG, L&T on "Statue of Unity, a tallest statute in the world". The Statue of Unity is a colossal statue of Indian statesman and independence activist Shri Vallabhbhai Patel, who was the first deputy Prime Minister and Home Minister of independent India. It is located in the state of Gujarat, on the Narmada River in the Kevadiya colony, facing the Sardar Sarovar Dam 100 km southeast of the city of Vadodara and 150 km from the city of Surat.

At 182 metres, the 'Statue of Unity' is the tallest statue built in the history of mankind ever. Capable of enduring wind speeds of over 180 kmph and earthquakes measuring up to 6.5 on the Richter scale, it can justifiably claim the mantle of being the strongest statue yet. And finally, the manner it was erected in just 33 months the 'Statue of Unity' is by far the fastest built structure of its kind anywhere in the world. The 'Statue of Unity' is a remarkable piece of engineering and a confluence of art and technology. Further, what make the Statue of Unity stand out from previous such endeavours, besides the jaw-dropping scale, is that rare mix of engineering and digital ingenuity. The entire process from Concept to Commissioning was completely driven by Technology. The physical Structural system and wind tunnel analysis done during the development of the statute were highlighted during the session.

Discussion

It was brought out that in recent times there is a lot of integration between civil engineering and other services. There is a gap in interservice coordination between civil and other services. This gap is to be bridged. The Performance based design may be included in the curriculum of engineering students.

1.2) Technical Session-II: Amrit moments in Chemical Engineering:

The Session covered the topics on “Sustainability challenge: One perspective”; “Agrochemicals in India: Current Challenges and Way Forward” and “Role of Engineers in Indian Pharmaceutical Industry”. This session was chaired by Shri Bimal Goculdas, Managing Director and Chief Executive Officer, The Dharamsi Morarji Chemical Company Limited (DMCC). He is also the Vice President of the Indian Chemical Council (ICC). He has chaired several expert committees of the ICC, including the Sustainability committee and the Technology committee.

Talk I: Sustainability Challenge: One Perspective

The talk was delivered by Dr Ajit Sapre, Group President - R&T, Reliance Industries Ltd (RIL) on “Sustainability challenge: One perspective”. The talk was based on the fact that rising standards of living and rapid urbanization will increase the demand for energy, food, clean water, nutrition and health solutions. This will further strain the resources meant to combat climate change. Major corporations are aggressively pursuing “Net Zero” goals to drive sustainability. Initiatives in renewable energy, electrification, hydrogen economy for deep decarbonisation, circular economy for resource conservation, etc., will need to be accelerated in India.

In addition to adopting relatively mature technologies (e.g., solar, wind, Li-ion battery, etc.), in India, we need to develop and commercialize home grown world-leading inventions in engineering solutions, catalysis, life sciences, and photosynthesis to meet the sustainability challenge. RIL has committed a significant R&D effort to be part of this exciting sustainability journey. A few leading R&D developments at RIL that have huge commercial potential were briefly discussed: 1) Organic waste to renewable oil, 2) Mixed waste plastic conversion to light crude, 3) Biomass catalytic gasification for green hydrogen production, 4) CO2 capture from flue gases, 5) Algae to bio-crude, and other high value

products including nutraceuticals, proteins, biomaterials, etc., using solar energy, sea water on marginal land. To be commercially competitive and make a sustainable business, improvements in many different areas of science and engineering are being integrated and scaled-up. Advances in synthetic biology will serve as one of the most important pillars of the 4th Industrial revolution, where biological, digital and physical platforms will merge to create sustainable products.

It was mentioned that to commercialize Indian R&D outcomes in the world markets, we need an eco-system of ample supply of risk capital, strong R&D infrastructure, and efficient mechanism to connect inventors to investors. For Indian inventions to progress to commercialization, we will need significant efforts in translational R&D, stronger public-private partnerships, and Government of India policy support.

Talk II: Agrochemicals in India: Current Challenges and way forward

The talk was delivered by Dr Ajit Kumar, Principal Technical Advisor, UPL Ltd on "Agrochemicals in India: Current Challenges and way forward". Modern agriculture relies almost exclusively on Agrochemicals to prevent the crop losses (approximately Rs. 4 lac crores, annually) by pests and diseases. It is heartening to note that our Government has identified Agrochemicals as a champion sector, so it is logical that we give a holistic look and identify what ails this sector and what can be a forward. There is no denying from the fact that use of agrochemicals since last 60 years has helped us as to ensure sustainability in food as well as nutritional security. Ever since, agrochemical industry has come of an age. Today, we are world's 4th largest agrochemical producer after USA, China and Germany. However, with enabling policy support, we can do far better towards US$ 5 trillion economy goal as our export share of agrochemicals is less than 4% in global agrochemical market of approximately US$ 70 billion.

Unfortunately, negative portrayal of agrochemicals by foreign Funded NGOs, has damaged its image. There seems to have adverse impact of this propaganda on policy makers. Proposed ban of 27 molecules and draconian provisions of upcoming Pesticides Management Bill (PMB) are a case in point. Three issues highlighted during the talk were, import of formulation without registering technical grade pesticide, proposed ban of 27 molecules and draconian provisions of upcoming Pesticides Management Bill (PMB). 'Make in India', 'Ease of Doing Business'; 'Atma Nirbhar Bharat' etc. is a far cry under current policy regime. It needs to be re- aligned with vision of our Hon'ble Prime Minister.

Discussion

At the end, it was brought out that the fundamental challenge in India is GDP Growth to employ and feed the people. An alignment with UN Sustainability challenges and managing climatic challenges are the major concerns. We need to reuse, recycle and use renewable energy. We should try to focus on reducing the agrochemical residual into the food chain and try to change the image of agrochemical industry in the eyes of public.

Talk III: Role of Engineers in Pharmaceutical Industries

The talk was delivered by Shri Rajendra Chunodkar, President – Manufacturing Operations, Lupin Limited on "Role of Engineers in Pharmaceutical Industries". It brought out the growth of Indian Pharma Industry over the last decade which has been spectacular in the country. The Role of Indian Pharma Industry in global market is very important and engineers are required in the Pharma industry for creating new manufacturing facilities, operating manufacturing plants etc. The challenges such as reluctance of engineers to work in factories/ Shifts, Quality of

Engineers, Availability and Less attraction to Core Engineering were discussed during the session.

Discussion

The emphasis of Indian Pharma industry is to develop the APIs in India because of the regulations, we stopped the production of Active Pharmaceutical Ingredients (APIs) in India and depend on China for that. With the Production Linked Incentive (PLI) scheme for Pharmaceuticals instituted by the honourable Prime Minister of India we are less dependent on China for APIs and key sourcing materials. With newer plants coming up we will be less dependent on china for the development of APIs.

1.3) Technical Session-III: Amrit moments in Electronics/ Computer Engineering

This Session covered the topics based on:

I. "Indigenous Telecom Routers for the nations Cyber Security Infrastructure"; "4G/ 5G Developments in C-DOT"

II. "Indian Election Voting Machines: A Time trusted device"

III. "Centralized Admissions for Engineering Colleges in India".

The session was chaired by Shri VVR Sastry, Former Chairman and Managing Director (CMD) of premier Defense Public Sector Navaratna Company Bharat Electronics Limited (BEL), Bengaluru.

Talk I: Indigenous Telecom Routers for the nations Cyber Security Infrastructure

The talk was delivered by Prof Ashwin Gumaste, Department of Computer Science and Engineering, IIT Bombay on "Indigenous Telecom Routers for the nations Cyber Security Infrastructure". It was brought out that the Internet is a critical

infrastructure in the country especially for digital India. Much of core Internet equipment connecting points of presence to each other within a city, suburbs to one-another, cities to each other makes use of devices called high-speed switches and routers. Currently India imports much of this equipment from the West or from China and this comes at a high price and brings significant security risks such as malware and trapdoors.

The talk focused on Carrier Ethernet Switch Routers (CESRs) which were transferred to state-owned PSU, ECIL and Terabit SDN router designed and developed for DRDO. The difference between these products and cisco products were also highlighted. These products were based on the unique Omnipresent Ethernet (OE) paradigm that facilitated extremely low-latency and could route a packet in sub-1 microsecond, faster than any other product in the market at 1, 10 and 100Gb/s speeds. The low-latency meant that energy consumption was also reduced. The OE concept is a simplification of the IP and Ethernet address spaces using a simple network graph. The idea is to push labels that are locally relevant onto incoming packets for a given network. This way a CESR instead of having to work on a 128-bit IP address or 48-bit Ethernet address, now has to work on only 8-10 locally relevant bits. The trick is for a centralized controller to get full network view and assign these smaller locally relevant addresses. Using this source routing concept, the team built three boxes that have 1Gb/s to 10Gb/s interfaces and a capacity of up to 400Gb/s for processing.

Discussion

It was highlighted that we should focus on the right technology, significant integration and cutting power consumption significantly. A lot of research will happen in future in this area.

Talk II: 4G/ 5G Developments in Centre for Development of Telematics (C-DOT)

The talk was delivered by Dr RK Upadhyay, Executive Director & Chairman, C-DOT on "4G/ 5G Developments in C-DOT". During his talk, it was brought that Centre for Development of Telematics (C-DOT) has been in the forefront of Telecom technology innovation, indigenously designing and developing solutions aimed at meeting the specific requirements of national communication networks with key focus on rural areas and strategic & security-centric applications. C-DOT is working in the areas of switching, network management, optical, wireless & security applications. Some of the recent technologies that have been developed including 4G/5G, optical system, Wi-Fi, routers, security applications, quantum communication based security devices, ITU CAP based disaster management solutions etc.

He highlighted the advances in the communication field in the last half century and it will primarily focus on indigenous 4G/5G development at CDOT. The important milestones in the telecommunication, evolution of mobile communications, and journey of CDOT's telecom path so far, Technologies of CDOT, current focus, impact of Technological advances and future trends in 4G and 5G were also mentioned.

The key considerations that were highlighted for consideration of policymakers during the session are as under.

(a) Incentivizing the local industry with specially created schemes and policies to boost indigenous manufacturing and encourage creation of digital infrastructure in villages and inhospitable terrains.

(b) Adequate funding shall be ensured for indigenous R&D endeavours and capacity building (creation of well-equipped test beds, prototyping labs, electronic assembly/ fabrication facilities, etc.)

(c) India- specific standardization/ certification of 4G/ 5G equipment and systems/ sub -systems should be made mandatory for the deployment; This will also address underlying security issues.

(d) Availability of adequate spectrum for testing and trials of diverse use cases should be ensured on priority basis.
(e) Govt. procurement tenders should also allow MSMEs, startups and other small local manufacturers for bidding.
(f) An effective and well-coordinated mechanism for collaboration amongst R&D, academia, industry, start-ups and Telecom association should be worked out for exchange of knowledge.
(g) Implementation of "5G for All" should be an immediate priority; Rural and Remote Areas should reap the dividends of these technological innovations.

Discussion

The processor-based approach is followed nowadays for development of products and it is independent on hardware. Hence, it is scalable. The data accelerator cards are being used and CDOT has already started developing data accelerator cards.

Talk III: Indian Election Voting Machines: A Time trusted device

The talk was delivered by Prof Rajat Moona, Director, Indian Institute of Technology Bhilai on "Indian Election Voting Machines: A Time trusted device". Indian Election voting machines are in use for electoral processes since 1989. After the parliament adopted its use in the elections, the voting machines have been a dependable and hallmark device for the elections. Since then there had been three generations of machines. The talk focused on various engineering aspects of the voting machine which make them a fortress and dependable machine for Indian Elections. During this session, components, uniqueness, secured design features of Indian EVM, Voter Verifiable Paper Audit Trail (VVPAT) and newer technologies namely Electronically Transmitted Postal

Ballet System (ETPBS), Remote Voting, Block Chain and Internet based voting were covered.

Talk IV: Centralized Admissions for Engineering Colleges in India

The talk was delivered by Prof Surender Baswana, Department of Computer Science and Engineering, IIT Kanpur on "Centralized Admissions for Engineering Colleges in India". IITs are known globally for their excellence in technical education, research, and innovation. These institutes have also arguably the most competitive process for admitting students at undergraduate level: out of the 1.2 million annual applicants, only less than 1 percent are admitted. However, it was very puzzling and frustrating that, until 2015, about 600 available seats at the IITs were consistently unfilled annually. One key reason for seats remaining vacant was as follows. From the 1960s to 2014, the admissions to IITs were conducted under one umbrella. Only slightly less sought after than the IITs are the non-IIT Centrally Funded Technical Institutes (CFTIs). The admissions to the non-IIT CFTIs were conducted under a separate umbrella, after completion of the IIT admissions. Each candidate was eligible to apply for a seat in each of the two sets of institutes, and several hundred candidates would indeed receive two offers, one at an IIT, and later, another one at a non-IIT. Each such candidate could use at most one of the seats, leaving a vacancy in the other seat.

At present there are 23 IITs in India. In 2015, a joint seat allocation process based on the Deferred Acceptance (DA) algorithm of (Gale and Shapley 1962) was designed. This process brings all the over 80 CFTIs (IITs + non-IITs) under one umbrella for admissions. Each candidate submits a single preference list over all available programs and receives no more than a single seat from the system, based on her submitted preferences and her rank in each relevant Merit List.

Though the DA algorithm looks simple and easy in theory, the joint seat allocation process had to address various challenges. First challenge was that the seat allocation must incorporate complex rules regarding multiple types of seat reservations for affirmative action. In addition, it is not permitted, in anticipation of attrition, to speculatively admit more students than the capacity. Finally, despite complexities, the process is required to be completely transparent (unlike many other college admissions mechanisms worldwide). The joint seat allocation process addressed all these challenges and has, since 2015, provably reduced vacancies at the IITs by nearly three-fourths. This process, though originally designed to reduce the vacancies at the IITs, is the ideal way of seat allocation wherever there are institutes with multiple Merit Lists.

Discussion

It was brought out that a lot of innovative work has been done and scope exists for future development also. Due to financial encouragement by Govt. of India, impact of China and incentives for local development a better future will be seen in the Electronics and Communication field.

1.4) Technical Session-IV: Amrit moments in Strategic Sector

This Session covered the topics based on:

I. "Dreams to Drums and Beyond – Journey of Heavy Water Programme in India"

II. "Indian Fast Reactor Programme: Current Status and the Way Forward"

III. "Technology Development and Incubation in BARC towards Atma NirbharBharat"

IIII. "Indian Aeronautics Industry – all set to takeoff"

V. "Achievements and Journey of ISRO".

The Session was chaired jointly by Prof AB Pandit, Vice-President, INAE & Vice-Chancellor, Institute of Chemical

Technology, Mumbai and Dr U Kamachi Mudali, Vice Chancellor, VIT Bhopal University & Honorary Professor of Practice, IIT Madras & Formerly Distinguished Scientist, Department of Atomic Energy (DAE), Chairman & Chief Executive, Heavy Water Board (HWB), Mumbai.

Talk I: Dreams to Drums and Beyond – Journey of Heavy Water Programme in India

The talk was delivered by Dr V K Khilnaney, Director (Operations), Heavy Water Board, Mumbai on "Dreams to Drums and Beyond – Journey of Heavy Water Programme in India". As an integral part of the three phase nuclear programme initiated by Dr Homi Bhabha, Heavy Water Board has consistently reinvented itself with development of new technologies broadly covered under novel isotope separation processes.

The talk covered the journey of the board, starting from development of the technology to the setting up and successful operation of commercial plants for production of heavy water. Visionary planning and distinctive management has guided the board to become a global leader of heavy water. The challenges faced throughout, in the face of embargoes and technology denial regimes, along with the strategies adopted; impact of industrial infrastructure, interaction with academia and the management were also brought out during the talk. Having mastered the technology and mastering the isotope separation, board moved on to other difficult isotope enrichment of Boron 10 and Oxygen 18. While the boron-10 primarily finds application in nuclear field, the Oxygen-18 is of societal importance and used for detection and management of cancer in addition to the energy expenditure studies carried on the soldiers working under extreme altitudes.

The enrichment of both the isotopes has been successfully achieved and talk highlighted the key aspects from concept to commercial deployment related to both the technologies. The very exiting non- nuclear applications of 'Deuterium and

heavy water' and expect to kindle the excitement among the engineering fraternity were also mentioned.

Discussion

The future road map is to study the aging of the nuclear plants. Augmentation is required. Aging management studies are in progress. Very little capital expenditure is envisaged for production of heavy water.

Talk II: Indian Fast Reactor Programme: Current Status and the Way Forward

The talk was delivered by Dr AK Bhaduri, DAE Homi Bhabha Chair & former Distinguished Scientist & Director IGCAR on "Indian Fast Reactor Programme: Current Status and the way forward". During the talk it was brought that the Sodium-cooled Fast Breeder Reactors (FBRs) and associated fuel cycle technologies form the second-stage of India's three-stage nuclear power programme based on domestic nuclear resources. Since 1985, Indira Gandhi Centre for Atomic Research (IGCAR) is successfully operating a 40 MWth Fast Breeder Test Reactor (FBTR), fuelled with a unique plutonium-rich mixed carbide fuel. FBTR has served as test bed for various experiments, structural material irradiation, isotope generation and different types of fuels viz., carbide, oxide and metallic.The mixed carbide fuel has demonstrated a record burnup of 165 GWd/t and has been operated on a campaign mode at 32 MWt producing 8 MWe electricity.

It was highlighted that currently, the 500 MWe Prototype Fast Breeder Reactor (PFBR), designed and developed by IGCAR, is in advanced stage of commissioning. The design of PFBR incorporates several state-of-art first-of-a-kind features and is an industrial-scale techno-economic viability demonstrator for India's FBR program. IGCAR is presently also engaged in the design of 600 MWe mixed oxide-fuelled FBRs incorporating

many more advanced features. Further, for the future, IGCAR has initiated development program on use of metallic fuel in FBRs for faster breeding. Demonstration of fuel fabrication and pyro-/ aqueous-reprocessing technologies for metallic fuels on an engineering scale is being pursued.

During his talk, he covered need for nuclear energy & nuclear resources, Fast Breeder Reactor: a vital stage in Indian Nuclear Power Programme, features and achievements of Fast Breeder Test Reactor and growth and minimization strategy. In addition to above, Approach and Evolution of Reactor Design were also covered. The required growth in electricity capacity necessitates growing for nuclear in larger way and renewables as far as possible.

Talk III: Technology Development and Incubation in BARC towards AtmanirbharBharat

The talk was delivered by Dr Archana Sharma, Group Director, Beam Technology Development Group (BTDG), BARC Mumbai on "Technology Development and Incubation in BARC towards AATM Nirbhar Bharat". The Bhabha Atomic Research Centre (BARC) has always worked towards self-reliant mode and made significant progress to give its benefits to society through power, health care, agriculture, supercomputing and frontline R&D. During the talk it was brought out that in today's context it becomes more relevant to spread this technology from lab to land, R&D to field deployment. To name a few, electron accelerator technology is indigenously developed in BARC for various applications such as cargo-scanner for security/safety, as food irradiator to enhance shelf life of agro-products, waste water/flue gas treatment.

It was mentioned that cold and hot Plasma technology are being matured towards solid waste processing, decontamination and spheroidization. Electron beam welding & welding machines are also successfully developed to meet

international standard. Laser based instruments for strategic usage and medical sector have been demonstrated. Multi gigawatt pulsed power technology is also pioneered by BARC for specified mandates. These technologies are being transferred to interested vendors and in some cases by incubation with industry partner to make progress faster and mentoring the industry simultaneously.
The talk highlighted current state of technology, Incubation of indigenous technology, Indigenous Accelerator technology and Pulsed Power and Electromagnetic Applications, multiple pulse welding for HFRR and PFBR applications with post weld analysis with (APP-MMD-IGCAR).

Talk IV: Indian Aeronautics Industry – all set to takeoff

The talk was delivered by Shri Shyam Chetty, Former Director, CSIR-NAL Project Director
(LCA-CLAW), Bengaluru on "Indian Aeronautics Industry – all set to take off". The talk covered that the Indian Aeronautics / Aerospace industry during the recent years has seen an aggressive growth, thanks mainly to the several new policies, major national level project sanctions and bold initiatives taken by the government under the "Atmanirbhar Bharat" & "Make in India" Programmes. The Aeronautics industry comprising of Government funded entities, large / medium private sector companies and MSME's, now has presence cutting across all segments of the value chain, namely R&D, Engineering Design, Manufacturing, Assembly, Production, Certification & MRO. It is therefore not surprising that the industry which has been joined recently by several new hardware start-ups is all set to catapult itself into the international orbit and cater to the ever increasing demand in Manned and Unmanned Air vehicles, Subsystems, Components & Support Equipment.

The talk showcased the recent success stories in Indian Aeronautics, and also highlight the various initiatives taken recently by the government to further accelerate the growth in the industry. Last but not the least, it will describe in brief the immense opportunities the future military and civil aircraft programmes which are in various stages of design and development will bring to the country / industry. He highlighted that there has been a sudden spurt in the growth of the aerospace and defence industry which led to an increased participation of the private industry thus providing a major boost to the indigenous effort. In addition to above, he also highlighted that developing new technologies indigenously is the need of hour. It is important that country continues to make large investments in the Aerospace and defence sector not just for strengthening national security but also ensuring overall development of the Engineering industry in the country.

Talk V: Achievements and Journey of ISRO

The talk delivered by Shri AS Kiran Kumar, Former Chairman, Space Commission, Chairman, ISRO and Secretary, Dept of Space, Govt. of India focused on objectives, achievements and journey of ISRO in five decades. Dr Vikram Ambalal Sarabhai was an Indian physicist and astronomer who initiated space research. His talk focused on the evolution of space technology and how India is using space technology for the developmental from 1950 onwards. A person who does not know reading and writing get advantages of the latest space technologies to perform his daily life chores. For example, a fisherman goes for fishing based on the satellite-based images of ocean colour and food chain of fish. Evolution in broadcasting, telephonic connectivity and weather forecasting took place because of space technology. Various departments like Mahalanobis National Crop Forecasting Centre, Delhi, Water Resource Board and

Crop forecasting centre provide specific information to our country beyond borders.

At the end of the session, it was brought out that India is world leader in heavy water technology and biggest plant is in India. Journey of India from a drop to heavy water drum and beyond is remarkable. BARC has mastered various technologies used for various societal and industrial and other applications. India is a leader in various technologies associated with aircraft industry. Department of Space mastered various technologies in five decades not only in sky but on land and benefitted the nation as well as the common man. India is a leader with 104 satellites in the space.

2) Second Plenary Talk: Dilemmas at the Intersection of Scientific Temper and Engineering Ethics

The second Plenary Talk was delivered by Prof VM Naik, Department of Chemical Engineering, IIT Bombay on "Dilemmas at the Intersection of Scientific Temper and Engineering Ethics". The Technology endeavours impact the society positively and negatively. Hence, we as Technology creators and policy makers ought to apply our mind to issues of engineering ethics. Technology is galloping at a frightening speed causing anxiety and concerns on several fronts. Institutes of academic excellence have started introducing engineering ethics as a core course.

The 19th century witnessed some spectacular technologies delivered by engineers to transform the quality of life. For example, in the year 1876, Alexander Graham Bell patented the telephone and AC induction motor was invented by Nicola Tesla in the year 1888 etc. Early codes focused mostly on "Micro Ethical" issues related to Professional's honesty, sincerity and loyalty. The major objective was to behave honourably, responsibly, ethically and lawfully to honour, reputation and usefulness of the profession.

The presentation covered the fact that the new dilemmas are far more complex. Their comprehension and resolution demand the spirit of objective critical enquiry, and readiness to accept change in revered theories in the light of unbiased empirical facts. These are the hall marks of Scientific Temper as a way of life. Such an enquiry may even lead to rejection of a ruling paradigm of developmental economics and necessitate search for a different paradigm, as has happened in the field of Natural Sciences, time and again. The Provocation for code of ethics by professional bodies of engineers in early 20th century, the Post-World War II dilemmas about societal determination of technology and technological development of society, the discourse of value neutrality of technology and inclusion of social justice in the theory of engineering ethics, scientific temper and theory of justice in the spirit of scientific temper given by John Rawls.

Recommendations

Theme II: Achievements of Indian Engineering – Azadi ka Amrit Mahotsav
October 27, 2021

(As the second day session was mainly meant to share the success of Indian Engineering achievements(Amrit Moments) of the past few years, the talks centered around the technical aspects of these selected projects and hence the recommendations that emerged from these talks and deliberations were more of general nature and not specific to any issue.)

1) **Civil Engineering:** Lot of integration between civil engineering and other services in Mega projects. There is a gap in inter-service coordination between civil and other services. This gap is to be bridged.
   The Performance based design may be included in the curriculum of Graduate Engineering courses.

2) **Chemical Engineering:**
   2.1) Developing and commercializing new technologies has to be focussed as part of 'Make in India'. In this direction, an eco-system of ample supply of risk capital, strong R&D infrastructure and efficient mechanism to connect inventors to investors has to be created.

   For Indian inventions to progress to commercialization, significant efforts in translational R&D, stronger public-private

partnerships and Government of India policy support are needed

2.2) Import of formulation without registering technical grade pesticide, proposed ban of 27 molecules and draconian provisions of upcoming Pesticides Management Bill (PMB) are the issues for Pesticide Industry.

Atma Nirbhar Bharat' & 'Make in India' are to be re- aligned with the vision of our Hon'ble Prime Minister.

2.3) The emphasis of Indian Pharma industry is to develop Active Pharmaceutical Ingredients (APIs) in India and not to depend on China for that. With the Production Linked Incentive (PLI) scheme for Pharmaceuticals instituted by the honorable Prime Minister of India, dependency on China for APIs and key sourcing materials will be minimized.

Production Linked Incentive (PLI) scheme for Pharmaceuticals instituted by the honourable Prime Minister of India has to be effectively executed.

3) Electronics and Computer Engineering:

A lot of innovative work has been done and scope exists for future development in this segment. Due to financial encouragement by Govt. of India, impact of China and incentives for local development a better future is envisaged for the Electronics and Communication field. The key considerations for policymakers that were highlighted during the session are as under.

3.1) Incentivizing the local industry with specially created schemes and policies to boost indigenous

manufacturing and encourage creation of digital infrastructure in villages and inhospitable terrains.

3.2) Adequate funding to be ensured for indigenous R&D endeavours and capacity building (creation of well-equipped test beds, prototyping labs, electronic assembly/ fabrication facilities, etc.)

3.3) India- specific standardization/ certification of 4G/ 5G equipment and systems/ sub -systems should be made mandatory for the deployment. This will also address underlying security issues.

3.4) Availability of adequate spectrum for testing and trials of diverse use cases should be ensured on priority basis.

3.5) Govt. procurement tenders should also allow MSMEs, start-ups and other small local manufacturers to be participants for bidding.

3.6) An effective and well-coordinated mechanism for collaboration amongst R&D, academia, industry, start-ups and Telecom association should be worked out for exchange of knowledge.

3.7) Implementation of "5G for All" should be an immediate priority; Rural and Remote Areas should reap the dividends of these technological innovations.

4) Strategic Sector:

4.1) The future road map is to study the aging of the nuclear plants. Augmentation is required. Aging management studies are in progress. Very little capital expenditure is envisaged for production of heavy water.

Augmentation of old nuclear plants and Capital expenditure for production of Heavy Water is needed.

4.2) Large investments in the Aerospace and defence sector are needed not just for strengthening national security but also for ensuring overall development of the Engineering industry in the country.