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NITI Aayog

Workshop on

Carbon Capture, Utilization, and Storage (CCUS) in Indian Cement Sector

16 January 2025

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About NITI Aayog

The National Institution for Transforming India (NITI Aayog) was formed via a resolution of the Union Cabinet on January 1, 2015. NITI Aayog is the premier policy 'Think Tank' of the Government of India, providing both directional and policy inputs. While designing strategic and long-term policies and programmes for the Government of India, NITI Aayog also provides relevant technical advice to the Centre and States. The Government of India, in keeping with its reform agenda, constituted the NITI Aayog to replace the Planning Commission instituted in 1950. This was done in order to better serve the needs and aspirations of the people of India. An important evolutionary change from the past, NITI Aayog acts as the quintessential platform of the Government of India to bring States to act together in national interest, and thereby fosters Cooperative Federalism.

Executive Summary

A workshop was held on the "Carbon Capture, Utilization, and Storage (CCUS) in the Indian Cement Sector" on 16th January 2025 at Vigyan Bhawan, New Delhi. The workshop is part of India's ongoing efforts to achieve its net-zero target of 2070 and ensure a sustainable future. Decarbonizing the cement sector is vital for meeting the country's long-term environmental goals, and to achieve that, CCUS needs to play a crucial role in reducing emissions in the cement sector.

The workshop saw participation from Principal Scientific Advisor to Government of India, Prof. Ajay Kumar Sood, Dr. VK Saraswat, Member, NITI Aayog; Sh. Pankaj Agarwal, Secretary, Ministry of Power; Dr. N. Kalaiselvi, DG CSIR and dignitaries from government, PSUs, industry, think tanks, and academia.

CCUS offers a unique set of tools for decarbonizing hard-to-abate industries crucial for India's economic growth, such as steel, cement, chemicals, and fertilizers, which heavily rely on fossil fuels. It enables a cleaner coal gasification economy, allowing for the more sustainable utilization of India's vast coal reserves. CCUS also supports the hydrogen economy by enabling blue hydrogen production - paving the way for a broader transition to green hydrogen based on renewable energy. Furthermore, CCUS can create new economic opportunities in cement sector by establishing new markets.

The workshop extensively explored the landscape of CCUS technologies, encompassing various carbon capture methods, CO2 utilization pathways (such as urea production and mineralization) and geological storage options. Continuous research and development were recognized as essential for improving the efficiency and minimizing the environmental impact of CCUS technologies.

Leading cement companies presented their decarbonization strategies, emphasizing a multi-pronged approach. This includes optimizing production processes, improving energy efficiency, and increasing the use of renewable energy sources. Maximizing the use of alternative fuels like biomass and waste-derived fuels is another key strategy to reduce reliance on fossil fuels. Furthermore, developing and promoting the use of low-carbon cements, including those with higher levels of clinker substitutes, is a significant focus. Finally, companies are actively investigating and exploring the feasibility of various CCUS technologies, including carbon capture, utilization, and storage options.

The workshop provided a valuable platform for stakeholders, including industry leaders, researchers, and policymakers, to engage in comprehensive discussions on the challenges and opportunities associated with CCUS in the Indian cement sector. The findings and recommendations from this workshop will serve as a crucial guide for the development and implementation of effective decarbonization strategies for the industry.

Background

India's cement industry has an installed capacity of 594.14 million tonnes (2022-23) and produced 361 million tonnes in 2021-22. With 333 manufacturing units, including 150 large plants, cement consumption in India is 260 kg per capita, below the global average of 540 kg, indicating growth potential.

Cement demand grew at a 6.2% CAGR (FY06-23), driven by strong domestic demand and increased government infrastructure spending, rising from 18-20% to over 28% in the last two years. Historically, demand growth has been 1.1-1.2x GDP growth over the past 30 years).

The global call for urgent and decisive action against climate change reverberated profoundly during COP26, as the Hon'ble Prime Minister of India Shri Narendra Modi fervently pledged India's dedication to achieve net-zero carbon emissions by the year 2070. This commitment reflects a national resolution to navigate the path toward sustainability while harmonizing economic growth. The spotlight has shifted onto Carbon Capture, Utilisation, and Storage (CCUS) technologies as potent instruments to decarbonize cement sector, a particularly hard-to-abate industry.

Around 48 CCUS initiatives have been taken by the major cement producers around the globe with a total carbon dioxide emissions reduction potential of around 36.44 MT CO2/Year. While some of them are still at the study phase or pilot scale, a few of the companies have gone full-scale commercial and are in the construction phase and are expected to come online in the next five years. Therefore, it is imperative that a technology and policy support based roadmap be prepared for the Indian Cement industry for Carbon capture, Storage and utilization (CCS&U) that would go a long way in taking investment decisions by the Cement manufacturers to reduce GHG emissions

Inaugural Session

During the inaugural session of the workshop on Carbon Capture, Utilization, and Storage (CCUS) in the Indian cement sector, several key speakers set the stage for an insightful and productive discussion

Dr. Anshu Bhardwaj, Program Director (GT, E&C) at NITI Aayog, delivered the welcome address, laying a solid foundation for the workshop.

Shri Ishtiyaque Ahmed, Senior Adviser (Industry) at NITI Aayog, contextualized India's cement sector, presenting key data on its potential and sustainability opportunities. He provided an overview of India's carbon emissions and reduction policies, explaining how adopting CCUS could pave the way for a cleaner future. He also highlighted the challenges that lie ahead

The Principal Scientific Adviser to the Prime Minister stressed that energy alone cannot drive India toward a net-zero economy and underscored the challenges of decarbonizing the cement sector, a hard-to-abate industry. He highlighted the necessity of balancing economic growth with emissions reduction and emphasized the importance of R&D in advancing CCUS technologies to achieve these goals.

Dr. VK Saraswat, Member, NITI Aayog highlighted the Honorable Prime Minister's leadership in steering India toward a net-zero economy through the nation's Nationally Determined Contributions

(NDCs). Emphasizing the critical role of carbon capture, utilization, and storage (CCUS) and clean technology in emissions reduction, he drew attention to the expanding global cement market, where the Asia-Pacific region plays a pivotal role. He underscored the potential for CCUS applications within India's cement sector and outlined possible pathways to achieve the country's net-zero target by 2070. Additionally, he stressed the importance of carbon pricing and climate finance as essential tools for decarbonizing India's cement industry.

Director-General, CSIR emphasized the critical role of CCUS in building a circular economy, drawing parallels to focused efforts on hydrogen. She noted that carbon is critical to all processes and that understanding and controlling carbon are essential steps beyond current practices.

Secretary, DST offered an economic perspective on the decarbonized future of the cement sector, emphasizing marginal abatement cost considerations.

Sh. Pankaj Agarwal, Secretary, Ministry of Power, indicated that the ministry is working on preparing the CCUS Mission. Sh. Ranjith Rath, CMD Oil India Limited, emphasized the urgency of innovative carbon capture and storage solutions, exploring geo-sequestration techniques and multidisciplinary approaches to mitigate emissions and achieve global climate goals. The discussions also highlighted the role of the Department of Science and Technology (DST) in developing CCUS technologies in the country. DST has also set up a Centre of Excellence on "Carbon Capture, Utilisation, and Sequestration" Cross-disciplinary Initiatives [DST-CoE-CCUS-CDI] to address the mitigation of CO2 emissions to achieve Net Zero aspirations of the Indian Government.

Key Takeaways:

- The session highlighted the importance of balancing India's economic growth aspirations with **environmental sustainability**, as CCUS being a key enabler for sustainable development in the cement sector.
- CCUS technologies are essential for achieving India's net-zero emissions targets, particularly for hard-to-abate sectors like cement.
- The cement sector is recognized as a major contributor to both overall and residual emissions in India, making it a primary focus for CCUS deployment during the session.
- **CCUS as Indispensable Solution:** CCUS is not just an option, but also a necessity for the cement industry to deeply decarbonize and meet emission reduction targets, going beyond energy efficiency improvements.
- A strong emphasis was placed on the need for collaborative efforts between government bodies (NITI Aayog, Ministry of Power, PSA), industry stakeholders, and research institutions to drive CCUS adoption.

- Further technological development and innovation in CCUS are vital to improve efficiency, reduce costs, and scale up CCUS technologies.
- **Policy and Financial Support Needed:** Supportive policies, clear regulatory frameworks, and significant financial investments from both public and private sectors are essential to overcome the economic barriers and incentivize CCUS implementation.
- India has the opportunity to emerge as a **global leader** in CCUS technologies and deployment, contributing significantly to global emissions reduction efforts.

Session 1: CCUS Technologies, Challenges and Feasibility in Cement Sector

The first session was chaired by Dr. VK Saraswat, Member (Energy), NITI Aayog. He invited the participants to present their thoughts different CCUS technologies and the various challenges associated with it.

Highlights of the presentations:

1. **Sh. Atanu Mukherjee, MN Dastur:** The cement demand will increase with India's increased focus on infrastructure drive. 80%-90% of the emission abatement of cement industry can be achieved with alternate fuels and CCUS. The decarbonization of cement industry will have an incremental cost of Rs. 2- Rs. 2.5/ kg cement produced. Selection of appropriate CO2 capture technology will be the key.
2. **Sh. Sashwattam, NTPC NETRA:** He has highlighted NTPC's efforts in harvesting liquid fuels from CO2 which is Category 1 utilization (carbon with hydrogen). A CO2 transport pipeline and a 100,000 TPA CO2 to methanol is being set up at Pudimadaka. He has requested designation of the "Green" tag for Methanol in line with Green Hydrogen definition.
3. **Sh. LP Singh, National Council for Cement and Building Materials:** He has stated that Oxyfuel technology for CO2 separation is the most cost competitive pathway currently available. NCCBM has developed electrification of the calciner for which they have filed patents. He has

also highlighted that mineralization as one of the biggest sequestration sectors. Carbonated aggregates can become carbon neutral and CO2 can be effectively sequestered over long time periods.

4. **Ms. Aparna Dutt Sharma, CMA:** She has highlighted that till date there is no commercially viable project in CCUS sector and that indigenization of key technologies can reduce the costs of carbon capture. There has to a long term and large-scale availability of carbon capture for carbon utilization requirement. She has also advocated for the formation of a dedicated CCUS research institute to conduct all feasibility studies in the CCUS sector**.**
5. **Ms. Devika Wattal, GCCA:** The feasibility of Carbon capture technology depends upon the scalability and whether the technology is standalone, retrofitted, etc. She has highlighted that support is needed for innovation. Finance support helps break cost barriers and de-risk investments across TRLs**.**
6. **Sh. Nitin Srivastava, Greengine Tech:** He has showcased a proprietary Microalgae based carbon capture technology. Flue gas is passed through these microalgae based photoreactors. The 1st pilot project is being set up in IOCL Mathura. He has stated the photoreactors has high carbon capture efficiency~75%. In addition to CO2, the reactors also capture Sox and Nox. The reactors are modular and scalable**.**

Key takeaways from the session-

- Central coordination of all R&D activities by the industries in CCUS sector.
- Advocacy for hubs and cluster model which can address a large number of logistics and finance related challenges.
- Mapping of sinks will be an important step for setting up of hub and clusters in the initial stages.
- Need for a robust CCUS financing framework to support CCUS adoption by the industries.
- Mapping of sinks will be an important step for setting up of hub and clusters in the initial stages as Storage is critical for CCUS
- Decarbonization adds marginal costs. Cement Emissions- 80-90% of emissions can be abated with CCUS and alternative fuels.
- Oxyfuel combustion and electrified calciners are promising. CO2 mineralization and nanomaterials offer added benefits.
- Centralized CCUS R&D and a dedicated institute are essential, along with indigenization and skill development.
- Pilot projects like microalgae-based capture and advancements in CO2 utilization in building materials show the potential.
- Coal-based power plants are focusing on green hydrogen, methanol production, and CO2 pipelines.

- A robust CCUS financing framework and financial aid for innovation are crucial to de-risk investments.

List of Speakers and Panelists:

1. **Dr. VK Saraswat, Member (Energy), NITI Aayog (Chair Person)**
2. Sh. Atanu Mukherjee, President & CEO, M N Dastur & Company Ltd
3. Sh. Shaswattam, Executive Director, NTPC-NETRA
4. Dr. L P Singh, DG, National Council for Cement and Building Materials
5. Ms. Aparna Dutt Sharma, Secretary General, Cement Manufacturers Association
6. Ms. Devika Wattal, Innovation Consultant, Global Cement and Concrete Association India
7. Sh. Nitin Shrivastava, Founder, Greengine Environmental Technologies Pvt Ltd.

Session 1A: Carbon Capture Technologies

This session was chaired by Atanu Mukherjee, CEO, Dastur Energy. He invited the participants to present their thoughts different CCUS technologies and the various challenges associated with it.

Highlights of the presentations

1. **Dr. Neelima Alam, Department of Science & Technology (DST)**: Dr. Alam described DST's journey in CCUS research and development, spanning from 2019 to 2024. She highlighted DST's collaborations and partnerships with various industries across different sectors. Furthermore, she acknowledged the active participation of industries in DST-funded projects, emphasizing their crucial role in advancing CCUS technologies.
2. **Dr. K.K. Pant, Professor, IIT Roorkee:** Discussed diverse CO2 utilization pathways, including thermochemical, photochemical, electrochemical, and biochemical routes. Highlighted research on CO2 conversion to methanol and other chemicals, emphasizing the importance of developing efficient indigenous catalysts. Addressed challenges like solvent degradation in amine-based technologies and the need for a comprehensive Life Cycle Assessment (LCA) and exergy analysis. Advocated exploring electrochemically driven capture and reducing energy consumption in mineralization. Showcased the development of a 1 TPD CO2-to-methanol pilot plant in Telangana.
3. **Dr. Ravi Babu, Sr. Principal Scientist, CSIR-CECRI:** Discussed on CSIR-CECRI's advancements in CO2 capture technologies. Addressed the challenge of capturing high-temperature CO2 emissions using technologies operating at room temperature. Showcased a novel adsorbent developed by CSIR-CECRI capable of capturing CO2 at ambient conditions, demonstrating performance comparable to global benchmarks. Discussed a pilot-scale facility (10 kg/day) and a larger 20kg/batch facility for adsorbent production. Highlighted the technology's potential for flue

gas CO2 capture in various sectors, including cement. Presented the development and commercialization of a DAC system for indoor air purification, addressing indoor air pollution concerns and a modular Bio-CNG plant design for biogas enrichment from biomass. Highlighted CSIR's presentation of the DAC technology to Dr. V.K. Saraswat.

4. **Prof. Sebastian Peter, JNCASR:** Presented integrated technologies for CO2 reduction and utilization, focusing on converting CO2 into valuable chemicals and fuels, like methanol and DME. Highlighted JNCASR's ongoing work in biomass-derived activated carbon for Direct Air Capture (DAC) and research on novel catalysts for efficient CO2 conversion. Discussed the projected costs of methanol production from a 1 TPD pilot plant (Rs. 13/liter) and emphasized the importance of fundamental research and potential collaboration opportunities with the cement industry.

Key Takeaways from the Panel Discussion and Presentations:

- Diverse CCUS approaches: The presentations highlighted various pathways for carbon capture and utilization, including microalgae-based solutions, CO2 conversion to chemicals and fuels, and advancements in adsorption technologies.
- Importance of indigenous technologies: Speakers emphasized the need for developing and deploying cost-effective and efficient indigenous technologies tailored to the Indian context.
- The need for robust partnerships between research institutions, industry players, and government agencies was reiterated for successful CCUS deployment.
- The session emphasized moving from lab-scale research to pilot-scale demonstrations and commercialization, exemplified by the projects showcased by CSIR-CECRI and IIT Delhi.
- Addressing cost and energy efficiency: Cost reduction, energy efficiency improvements in capture and utilization processes, and the need for detailed economic analysis were recurring themes.
- Indoor air pollution as an opportunity: CSIR-CECRI's presentation highlighted the potential of DAC technologies for addressing indoor air quality, presenting a valuable application beyond industrial settings.

List of Speakers and Panelists:

1. Atanu Mukherjee, President & CEO, Dastur Energy & M N Dastur & Company Ltd. (Session Chair, Dastur Energy)
2. Dr. Neelima Alam, Department of Science & Technology (DST):
3. Dr. K K Pant, Professor, IIT Roorkee
4. Dr. Ravi Babu, Sr. Principal Scientist, CSIR-Central Electrochemical Research Institute, Karaikudi
5. Prof. Sebastian Chirambatte Peter, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore

Q&A and Conclusion:

- Question to Prof. Sebastian Peter (JNCASR): An attendee asked about the space-time yield of his CO2-to-methanol catalyst, comparing it with NTPC NETRA's catalyst, which reports 12% conversion and ~70% selectivity.
- Prof. Peter's Response: Prof. Peter noted that yield is a better metric than conversion or selectivity and explained that 12% conversion aligns with typical recycling conditions. He highlighted that their JNCASR catalyst outperformed CRI's Johnson Matthey catalyst in space-time yield and emphasized benchmarking against the thermodynamic limit for methanol yield.

Session 2: Financing CCUS in India

Session 2 on "Financing CCUS in India" highlighted key strategies for reducing emissions, including CCUS feasibility studies by ADB, financing mechanisms by WBG, and sustainable technologies like LC3 cement by GIZ. Discussions focused on innovative solutions, mobilizing finance, and scaling low-carbon technologies to advance decarbonization in the cement sector.

Key Highlights of the presentation:

1. **Sh. Darshak Mehta, Asian Development Bank (ADB)**

   ADP presented a study they supported assessing the techno-economic feasibility of CCUS options at the Ariyalur cement plant of Dalmia Cement (annual capacity: 3.0 million tons) which took place in 2021-22. They shared their multi-criteria analysis which evaluated various CO2 utilization options, considering factors like capex, opex, payback period, market demand, and resource availability, identifying urea and mineralization as the top-ranking solutions for short-term implementation.

   Next, they gave a brief overview of four packages of study they conducting in the North-East. The project involves studying CO2 streams, utilization opportunities, CO2 storage locations, transport methods, geological modelling, and business models, with feasibility studies conducted across key areas. They highlighted package 2, hydrogen production through Methane pyrolysis (MP) which avoids CCUS for decarbonization of Steam Methane Reformation (SMR) based H2 generation from natural gas

   Suggested various methods of financing CCUS, drawing examples from similar cases. One example was waste disposal in nuclear power projects, where initial work is undertaken by an SPV and later

handed over to a statutory organization. Another was wind power transmission lines, where the first beneficiary makes the initial investment and recovers costs from subsequent investors.

2. **Ms. Natalia Kulichenko, World Bank Group:**

   World Bank spoke about how they are working on Financing CCUS in 11 countries and three regional activities. Their activities included assessing CCUS potential, developing economic and business models, evaluating environmental and social impacts, creating CCUS regulations, supporting a pilot CO2 storage project in South Africa, and assisting the governments of South Africa, Timor-Leste, Indonesia, Nigeria, and Egypt in developing legal frameworks, roadmaps, storage atlases, and business models for CCUS.

   The meeting discussed a combination of interventions required to mobilize long-term finance, unlock domestic financing, and de-risk investments for CCUS projects in India. Key interventions include raising capital in both hard and local currencies for large-scale ID projects, mitigating offtake risk to develop markets for CCUS technologies, and monetizing carbon credits under the Indian Carbon Market's Carbon Credit Trading Scheme. The objective is to enhance the availability of cost-effective financing and scale up markets for CCUS. The World Bank Group's role includes facilitation, stakeholder mobilization, and providing upstream support through IBRD for risk mitigation, regulations, and pre-feasibility studies, while IFC can support early-stage activities to demonstrate feasibility and bankability, share risks, and engage with government on regulations.

3. **Sh. Vaibhav Rathi, GIZ:**

   GIZ presented LC3 technology where they share the overview of LC3, by this industry can make Sustainable cement with lower clinker content and reducing CO2 emissions by ~40%. This invented internationally, developed in India by IITs and supported by Swiss Agency for Development. While they talk about advantages like BIS-certified (IS18189-2023), cost-effective and open technology.

   In the meeting it was also discussed that cement production contributes 8–9% of global GHG emissions, making it a critical sector for decarbonization. IIT Delhi in partnership with a real estate developer and Rocky Mountain Institute (RMI) is piloting LC3 applications in real-world projects. Beyond reducing emissions LC3 supports climate co-benefits by being considered for GRIHA-rated green building products and demonstrating its utility in critical infrastructure like water and sewage treatment. Ongoing innovations include exploring low-carbon materials like 3D printing and integrating solar concentrators for manufacturing with pilot studies validating LC3's performance under challenging conditions.

Key Takeaways and Action Points

- Dr. VK Saraswat (Member S&T NITI Aayog) asked for a White Paper on the SPV method of financing shared by ADP.

- Advancing CCUS Feasibility and Implementation: Focus on identifying viable CCUS technologies, such as urea production and mineralization, while leveraging multi-criteria analysis for short-term deployment.

- Strengthening Financing Mechanisms: Develop innovative funding models, including carbon credit monetization, risk mitigation strategies, and mobilizing long-term capital to support large-scale CCUS projects.

- Promoting Low-Carbon Cement Solutions: Accelerate the adoption of sustainable technologies like LC3 to reduce emissions in the cement sector, with real-world applications and integration into green infrastructure initiatives

List of Speakers and Panelists:

1. Sh. Rajnath Ram, Adviser (Energy), NITI Aayog (Session Chair)
2. Sh. Darshak Mehta, Energy Sector Group Consultant, Asian Development Bank
3. Ms. Natalia Kulichenko, Program Leader, World Bank
4. Sh. Vaibhav Rathi, Sr. Advisor, GIZ

Session 3: CO2 Utilization and Storage

The session was chaired by Shri Ranjit Rath, CMD, Oil India Limited, he emphasized the importance of the session, focusing on solutions for CO2 capture and permanent sequestration. He underscored the need for research and innovation in carbon capture to expedite its development in India. He emphasized that the cement industry relies on process, where emissions are unavoidable, and cannot be mitigated by process efficiency. Hence, carbon capture must play a pivotal role in bridging the gap. He stated that the session is designed to explore CO_2 sequestration, emphasizing the application of geosciences, along with presentations from experts in oil and gas exploration. The discussions will encompass a broad range of topics, including looping combustion, CO_2 utilization, sequestration, and storage, with contributions from specialists representing diverse institutions.

Key points: The session included the use of looping combustion to reduce CO2 emissions, with a Technology Readiness Level (TRL) of 7. The potential for CO2 Utilization and Storage (CCUS) in the cement industry is emphasized, particularly in the context of Enhanced Oil Recovery (EOR) and geological storage in regions such as the Deccan Volcanic Province. Another promising approach for carbon sequestration involves accelerated mineral carbonation in building materials. The cement sector's contribution to global CO2 emissions is significant, accounting for 5-7% of total emissions. Decarbonization strategies discussed include the implementation of public procurement standards,

increased use of municipal solid waste, and the integration of CCUS technologies, all aimed at reducing emissions from the sector.

Presentations on developments in CO2 utilization and storage:

1. **Dr. Ravindra D Gudi (IIT Bombay)** presented a novel looping combustion process that uses metal oxides as oxygen carrier between chambers, which separates CO2 from air, eliminating the need for filtering the emissions. The process can be modified to generate byproducts such as Methanol, DME and also hydrogen. This can also be adapted to use alternate fuels such as biomass and utilized as a source of power. He stated that this initiative is a step towards advancing the Circular Carbon Economy (CCE) in process plants.
2. **Mr Tshering Lama (Centre of Excellence of Energy Studies, OIL)** gave an overview of subsurface storage, which can be executed in Enhanced Oil Recovery (EOR) and Enhanced Coal Bed Methane Recovery (ECBMR). Such options reduce the requirement of creating storage infrastructure. He also gave breakdown of OIL's endeavors in Naharkatiya and Dikom, while also stating their collaboration with IIT Bombay and Texas A&M University.
3. **Dr. Nimisha Vedanti (NGRI)** explained the importance of sub-surface characterization for feasibility of CCS including the study of reservoir properties and injectivity. She mentioned similar studies done in Raniganj basin and Deccan basalts. Due to the wide nature of this efforts, the speaker said that entire CSIR network was involved in the project. The need for robust legal frameworks and regulatory support for CCS projects was emphasized.

4. **Dr. Kishor S. Kulkarni (CSIR – CBRI, Roorkee)** discussed the use of accelerated mineral carbonation in building materials to reduce CO2 emissions. The chemistry of carbonation in cement-based materials and the potential for generating building products were presented. The reuse of industrial and C&D waste for CO2 sequestration was highlighted and the results of experiments on lightweight aggregates and precast concrete elements were presented, showing increased CO2 sequestration.
5. **Dr. Vikram Vishal (IIT Bombay)** gave an overview of the activities of National Center of Excellence in CCUS at IIT Bombay, mentioning their projects with NTPC. He discussed the advancement of CO2 storage technology, including the development of disruptive capture plants and development of CCUS in a domestic ecosystem. The presentation covered the use of geological diversity in India for CO2 storage and the importance of geo-mechanical modeling. The challenges and opportunities in CO2 storage, including the need for continuous monitoring and regulatory frameworks, were discussed. The potential for CO2 storage in onshore and offshore areas was highlighted, with a focus on the role of seismic data and passive monitoring.
6. **Ms. Sushma Rawat (ONGC)** provided an overview of ONGC's efforts in geological storage for CCS and enhanced oil recovery. The potential for CO2 storage in saline formations and the role of fracture analysis and sealing integrity tests were discussed. The importance of transportation and logistics in CO2 storage projects was emphasized, with a focus on cost-effective solutions. She provided an overview of ONGC's future plans for CCUS projects and the potential for new pilots.

During the audience Q&A, cost-effectiveness of carbon capture systems and seismic risks in storage zones were addressed:

- Is PSA (Pressure Swing Adsorption) more cost-effective compared to other methods?
- Has ONGC and OIL developed a business model for this initiative? In response, it was stated currently, the company is focusing on pilot projects to assess the associated costs and does not yet have a business model in place. Once sufficient data is gathered, a domestic business plan will be developed and implemented.
- Prof. Vikram Vishal from IIT Bombay addressed the query about accessibility of data for use by other entities to allow them to perform their own analyses. ONGC and OIL have shared data with IITB for this purpose, and IITB also utilizes its own seismic equipment to collect additional data. Concerns were raised about the sites being located in seismically active zones and the potential risk of drilling exacerbating seismic activity. In response, it was emphasized that all stakeholders are fully aware of these risks and are taking them into consideration.

Key Takeaways & Closing Remarks:

- **Innovation & Research**: Accelerating the adoption of Carbon Capture, Utilization, and Storage (CCUS) will require continuous innovation and research. These efforts are essential not only to improve the technology's efficiency but also to enhance its role as a key tool in reducing carbon emissions globally.
- **Site Characterization**: The successful deployment of CCUS depends on the identification of optimal sites for storage. This requires comprehensive characterization to assess factors such as storage capacity, geological suitability, and accessibility. Ensuring these sites are well-suited for CO2 storage is crucial for the long-term viability of CCUS.
- **Challenges**: Several challenges need to be addressed to scale up CCUS, including:
    - Capital Costs: The initial investment required for CCUS infrastructure is significant, which may deter some stakeholders.
    - Absence of a Carbon Market: Without a well-established carbon market, it can be difficult to create the economic incentives needed for CCUS projects to be financially viable.
    - CAPEX & OPEX: High capital expenditures (CAPEX) for setting up CCUS facilities and ongoing operational expenditures (OPEX) present economic hurdles for widespread adoption.
    - Regulatory Frameworks: The lack of clear and uniform regulatory frameworks for CCUS projects can create uncertainty, hindering investment and development.
- **Importance of CCUS Hubs**: The establishment of CCUS hubs will be critical in pooling resources, sharing infrastructure, and facilitating collaboration across industries. These hubs can become focal points for innovation, scaling up technology, and optimizing the use of captured carbon across multiple sectors.
- Collaborations with Academia: Partnerships with academic institutions are essential for advancing research, developing new technologies, and finding innovative solutions to the technical and economic challenges of CCUS. Collaborative efforts between industry, academia, and research organizations will be crucial for the future of CCUS deployment.

In conclusion, addressing these challenges through innovation, research, and collaboration will be vital for the successful implementation and scaling of CCUS as a key component in reducing global carbon emissions.

List of Speakers and Panelists:

1. Session Chair: Shri Ranjit Rath, CMD, Oil India Limited
2. Dr. Ravindra D Gudi, Professor, IIT Bombay
3. Shri Tshering Lama, CGM - Centre of Excellence of Energy Studies (CoEES), OIL
4. Dr. Nimisha Vedanti, Senior Principal Scientist, CSIR - NGRI
5. Dr. Kishor S. Kulkarni, Senior Scientist, CSIR - CBRI, Roorkee
6. Dr. Vikram Vishal, Professor, IIT Bombay
7. Ms. Sushma Rawat, Director (Exploration), ONGC

Session 4: Vision and Plan for Implementation of CCUS in Cement Sector

Program Director noted his pleasure in attending the Workshop and Said that this session is all about who will implement the CCUS in Indian Cement Sector commitment to decarbonisation.

1. **Shri Sarvesh Gupta, McKinsey: Decarbonization Roadmap for the Indian Cement Sector by McKinsey:** McKinsey reported on the progress of the Decarbonization Roadmap for the Indian Cement Sector and noted that the CCUS programme is critical for net-zero. McKinsey highlighted that time is critical for net-zero. They mentioned Indian cement production is expected to grow ~5x by 2070 and Cement is a high emission sector, accounting for ~5% of India's emissions. They also mentioned Key Levers for Decarbonization & Green transition strategy to move towards net zero in cement sector using various levers & Commercialization of new technologies like kiln electrification & solar fuels, more efficient production of clinker and accounting for natural recarbonation may help move the cement sector closer to net zero.

   Main Highlights of Presentation: -

   MiCknsey updated on the CCUS vision and highlighted that it should capture 5 key points. These were:

- They Highlighted Commercialization of new technologies like kiln electrification & solar fuels, more efficient production of clinker and accounting for natural recarbonation may help move the cement sector closer to net zero
- They also mentioned Marginal Abatement Cost Curve for 2070 Emission. They provide Range of landed cost per tonne of clinker and key clinker substitutes: clinker (~USD 35-45), fly ash (~USD 30-35), slag (~USD 27-32), pozzolan (~USD 29-34).
- They evaluated 22 recommendations and narrowed down to 8 solutions and further aggregated into 4 high impact solutions Which are (a) Public procurement to drive usage of low carbon cement (b) Increased Usage of Municipal Solid Waste as Alternate Fuel in Cement Sector (c) Increased Usage of Clinker Substitutes in Cement Production(d) Carbon Capture Utilization (CCU) Pilots for Cement Sector

2. **Dr Raju Goyal, Ultratech Cement: Decarbonization Approach at Ultratech Cement:** Ultratech Cement thanked for opportunity to present and highlighted the Decarbonization Approach Used by Ultratech Cement with respect to Climate Focus. UTC added that 556 kg CO2/t Cems. Mat, 3.3x Plastic Negative, and 5x Water Positive. UTC added that Technology Options for Reduction Such as Cool Brook's RDH technology which Utilises renewable energy electrification, Carbon-Oro, Fortera Coomtech, Queens Carbon, NeoCrete and EnviCore. They Mentioned that for Decarbonization – Green Energy,7600 Floating solar photovoltaic panels installed at Awarpur unit.

   They also mentioned Decarbonization Initiatives 19,714,158 t CO2 Avoided emissions through blended cements, 40 integrated and grinding units are registered as Designated Consumers (DCs) under the PAT scheme, Bio-fuel - Use in our mining equipment to reduce carbon emissions, Drone surveys for optimization of haul road which contributes to increased productivity, fuel saving and reduction in carbon emissions, Green logistics: 480 Green Vehicles, including 5 electric vehicles, e-FAST India program - Commitment to NITI Aayog's decarbonization initiative. UltraTech has adopted the Water Positivity Index in its sustainability disclosures in 2018.

   They also mentioned many technological interventions that are required for Decarbonization such as **Carbon Reduction Technolo**gy Which Include (Carbon offset projects in community, Carbon Capture Storage and Usage, Oxyfuel/Oxygen Enrich CO2 absorption in Concrete,) **Process Technology** Which Involves (Alternative Calcination technology, Implementing Process Modelling, Use of AI/ML and Soft Sensors) **Energy,** which Includes (Hydrogen for energy production and

transportation, Use of Solar Energy in drying and clinkering process) **Material Technology** which involves (Developing LC3 cement , Evaluating Low clinker cement – Geopolymer, Belite clinker, Multi-blend, Usage of Red-Mud, LD Slag, High MgO Limestone, Usage of Recycled Concrete Aggregates Usage of Carbonated and Uncarbonated Recycled Concrete Fines) Product Technology Which Uses (New Carbon-Based: Synthetic fuel/Chemicals, Graphene, Nanotubes)

Main Highlights of Presentation: -

- UTC highlighted its role with respect to Climate Focus
- UTC highlighted Technology Options for Reduction Such as Cool Brook's RDH technology which Utilises renewable energy electrification, Carbon-Oro, Fortera Coomtech, Queens Carbon, NeoCrete and EnviCore.
- UTC added Drone surveys for optimization of haul road which contributes to increased productivity, fuel saving and reduction in carbon emissions
- UTC has added Water Positivity Index in its sustainability disclosures in 2018. They have Implemented the Increase water use efficiency in operations and Adopted water-saving systems & technologies and also Reducing dependence on surface & groundwater, Integrated watershed management - dams, ponds and reservoirs, Recycling and reusing community greywater

3. **Shri Anupam Badola, Dalmia Cement: CCUS Cement with a Blend of Economy and Sustainability by Dalmia Cement:** Dalmia Cement Presented CCUS Cement with a Blend of Economy and Sustainability They added Climate strategy is an efficient business strategy. They Highlighted Decarbonisation actions, partnerships and ambitions, they mentioned that DC are Globally, first in heavy-industry sector to share carbon negative ambition. They also mentioned that DC are Among the five Climate Defenders recognised by BBC World. They said that DC is Ranked 1 by CDP in global cement sector on Business Readiness for a Low Carbon Economy Transition.

   They flagged that they are first triple joiner globally of RE 100, EP 100 and EV 100. They also mentioned that we are the First Indian headquartered cement company to commit to Science Based Targets Initiative and have SBTi validated targets (SBTi). DC added that we are > 25 times Water Positive cement manufacturing Industry. They mentioned Decoupling CO2 emissions from growth, Realised low carbon transition through Clinker Factor Optimisation, Low Carbon Blended Cement, Renewable Electricity (RE 100), Fossil Free Thermal Energy, Energy productivity/efficiency

improvement (EP 100), Low carbon mobility. They also projected Decoupling CO2 emissions from growth by Advanced Technology Adoption: CCUS technologies under exploration: Urea, Soda Ash, Oxyfuel, Mineralisation, Olefins, 100% Low Carbon Cement Production: Maximisation of existing Blended Cements, New Cement/Clinker Chemistry : Development of new Low/Zero Carbon Cements, 100% Fossil Free Electricity (RE 100) : Adoption of efficient technologies such as, Solar, Wind, Pump Storage, Nuclear SMR, Green Hydrogen, 100% Fossil Free Thermal Energy: Switching to Renewable Biomass, Recycled Waste, Green Hydrogen, Heat Electrification, Solar Calcination, Oxygen Enrichment, Gasification, etc, 100% Electric and biofuels Vehicles : Electric Vehicles, Bio CNG and other Biofuels Technologies, Energy productivity: Doubling of the Energy Productivity (EP 100), Usage of new Technology with Reskilling, Access to Climate Finance: Availability of Green Grants, Risk Capital and Carbon Credits for adoption of Clean Technologies

Main Highlights of Presentation: -

- DC highlighted its role with Visualisation of a net zero cement plant from Grey to Green
- DC Presented the Estimation of Carbon Capture cost for Indian cement industry, with 35% process emissions re-carbonation rate, 0.222 tonne CO2/tonne of cement needs be captured for storage or utilisation by 2070
- DC added that Average capex of large-scale Carbon Capture plant – Rs. 600 to 2,300 Cr. /MTPA CO2
- DC also mentioned at estimated 1,500 to 2,000 MTPA production, 333 to 444 MTPA CO2 needs to be captured by 2070
- DC presented that CO2 capture Capital cost 2.7 to 10 lakh Crore at 2,000 MTPA cement capacity and 2.0 to 7.7 lakh Crore at 1,500 MTPA cement capacity by 2070 (at present values)
- DC also mentioned Carbon Capture Utilization Pathways for Cement Industry Such as Polyols, Precipitated Calcium Carbonate (PCC), Methanol, Urea, Soda Ash, Algal oils, Food grade CO2, Greenhouse CO2 and Synthetic Aviation Fuel (SAF)
- DC Mentioned Set strong mechanisms for Global Carbon Market under Article 6.2 and 6.4 to access high quality and high price global carbon markets

4. **Shri Saurabh Palsania, Shree Cement: Carbon Capture Technology & how it can revolutionize the cement Industry by Shree Cement:** Shree Cement provided an Overview of Carbon Capture Technology & how it can revolutionize the cement Industry. SC flagged out the

Contribution of India in CO2 Emission. SC added Cement Industry Volume generation of CO2 Emissions. They also mentioned Allocation of Volume in Process of Cement Production. They also mentioned Various Cement Decarbonization Levers such as Green Logistic (Including EV ,LNG & Hydropower Vehicles), Green Power (Including Utilization of Hydrogen for power substitution, Maximum utilization of Solar Power, Hybrid, Battery Storage etc), Alternative Fuels (including Post industrial waste of other industries, Increased focus to achieve higher thermal substitution rates), New Technologies (Including Use of Green Material – Fly Ash, Slag, Red Mud, Lime sludge, fire Clay, granite dust etc. and Use of CCUS Technology – Carbon Capture utilization & Storage

Main Highlights of Presentation: -

- SC highlighted its role with respect to Transition from fossil fuels to alternate non fossil fuels
- SC highlighted in Achieving 100% renewable energy usage in cement production, up from the current 56%.
- SC added that Replacement of diesel with hydrogen gas
- SC highted that it is very important to Implement CCUS (Carbon Capture, Utilization, and Storage) technology when it becomes economically viable

5. **Shri Brajesh Sharma, JK Cement: Decarbonizing Indian Cement Sector Endeavours by JK Cement Towards Decarbonization Journey by JK Cement:** JK Cement provided an Overview of Decarbonizing Indian Cement Sector Endeavours by JK Cement Towards Decarbonization Journey. JK Cement flagged its geographical presence in India. JK Cement added that Cement industry contributes to ~8% of total GHG and is a “Hard to Abate” another challenge is that Industry faces investor pressure towards decarbonization. They further highlighted that ESG considerations are now central to strategic decisions for Cement Industry and also mentioned Sustainable supply chains are critical to business continuity. They mentioned that challenges faced by Cement Industry are High carbon footprint of the process i.e. Calcination in cement manufacturing which is inevitable, Uncertainties regarding technology and regulatory development, New low carbon foot print products development & market acceptance, Issues obtaining regulatory permissions for producing low carbon products, Technological adoption like CCUS & Green Hydrogen. They highlighted that JKCL is a member of prestigious global organisation, and our climate-related targets are aligned and validated by them. They further added that JKCL has collaborated with prominent National organizations for Decarbonisation Strategy Such as Cement Manufactures Associations, National

Council for Cement and Building Material, GCCA India & Confederation of Indian Industry. The main Decarbonization Strategies are Energy efficiency technologies, Alternative fuels and Raw material, Pathways for reducing clinker factor, Carbon management

Main Highlights of Presentation: -

- JK highlighted its role with respect to that challenges faced by Cement Industry are High carbon footprint of the process i.e. Calcination in cement manufacturing which is inevitable
- They also mentioned that JKCL has collaborated with prominent National organizations for Decarbonisation Strategy Such as Cement Manufactures Associations, National Council for Cement and Building Material, GCCA India & Confederation of Indian Industry
- JK added that Technological adoption like CCUS & Green Hydrogen would be a great advantage in Cement Sector Industry

Key Takeaways:

1. **Technology & Innovation** – Adoption of kiln electrification, solar fuels, CCUS pilots, and green hydrogen for net-zero cement production.
2. **High-Impact Solutions** – Public procurement for low-carbon cement, increased use of waste-derived fuels, and clinker substitutes.
3. **Carbon Capture & Costs** – India's cement sector must capture 333–444 MTPA CO_2 by 2070, requiring ₹600–2,300 Cr. per MTPA CO_2.
4. **Renewable & Alternative Fuels** – Transition from fossil fuels to hydrogen, waste-derived fuels, and 100% renewable energy.
5. **Sustainability & Resource Efficiency** – Fuel-saving drone surveys, water conservation, and watershed management for sustainability.
6. **Industry Collaboration & Policy Support** – Partnerships with key organizations and policy frameworks for CCUS and decarbonization.

Officials' response:

The Session chair thanked all the presenters for their contribution and highlighted that this one-day workshop had been conducted, and that the lessons had highlighted a coherent message from the

sector which included the need to deliver quickly the Decarbonization Road Map of CCUS in India Cement Sector to achieve Net Zero Goal by 2070.

List of Speakers and Panelists:

1. Dr Anshu Bharadwaj, Program Director (Session Chair-Energy, Green Transition & Climate Change)
2. Shri Sarvesh Gupta, Associate Partner, McKinsey
3. Dr Raju Goyal, Chief Technical and Sustainability officer, Ultratech Cement
4. Shri Anupam Badola, Deputy Chief Sustainability officer, JSW Cement
5. Shri Saurabh Palsania, Jt. President – Strategic Sourcing, Shree Cement
6. Shri Brajesh Sharma, Head Corporate Sustainability, JK Cement

Session 5: Panel Discussion on Support Required for Implementation of CCUS in Cement Sector

The final session was chaired by Dr. V.K. Saraswat. Each panelist was invited to share their insights on the topic "Support Required for Implementation of CCUS in the Cement Sector." The session concluded with remarks from Dr. Saraswat, summarizing the key points discussed.

Insights shared by the Panelists:

1. **Dr. L P Singh** highlighted that the industry's significant progress, achieving 50% decarbonization, which he praised as a remarkable achievement. Despite the implementation of waste recovery systems, substantial gaps remain. He emphasized the need for additional initiatives, particularly the adoption of disruptive technologies, to close these gaps. He also discussed ongoing research efforts focused on developing new types of cement and their potential market introduction. He concluded by stressing that a combination of decarbonization efforts and carbon capture technologies is crucial for achieving Net-Zero emissions in the cement sector**.**
2. **Ms Aparna Dutt Sharma** proposed the establishment of a core committee or division to bring together all stakeholders in the cement industry. She emphasized that such an initiative would significantly enhance efficiency and cost-effectiveness. Additionally, she suggested to develop a

comprehensive policy to facilitate scaling CCUS projects from pilot phases to industrial-scale implementation. She also suggest to establish national research and development centers would support the creation of large-scale CCUS projects and provide training to industry professionals and Industry leaders should be engaged with the Government of India to understand its perspective and strategies, enabling better alignment and planning for CCUS adoption.

3. **Sh. Kaustubh Phadke, India Head, Global Cement and Concrete Association India** underscored the crucial role that CCUS will play in the development of Low Carbon Cement (LCC), highlighting that the cement industry needs substantial support for the development and deployment of indigenous CCUS technologies. Additionally, increasing the number of pilot project demonstrations is essential to effectively scale up adoption. Enhanced financial backing from the Government of India (GoI) is vital to propel CCUS implementation in the cement sector and thorough exploration and optimization of the industry's potential for carbon uptake are necessary to further bolster sustainability efforts.

4. **Dr. Anshu Bhardwaj** mentioned that NITI Aayog is planning an extensive study on two critical aspects of CCUS implementation.

    1. Utilization: The study will address questions related to the potential of CCUS, market size, and the long-term viability of such projects.

    2. Storage: It will identify appropriate sites in India for the development of carbon storage projects.

Closing Remarks by Dr. V K Saraswat

Dr. Saraswat indicated that the government plans to undertake specific initiatives to support the small-scale cement sector. These initiatives will include providing financial assistance for research and development in CCUS technologies.

Key Points from Dr. Saraswat's Address:

- Despite substantial decarbonization efforts, residual carbon emissions will remain, highlighting the critical role of CCUS technologies.
- Necessity of scaling up carbon capture capacity in the cement sector from pilot plants (1 ton per day) to industrial-scale systems (200–300 tons per day).
- Technology Selection: Technology choice should depend on carbon content in flue gases to ensure suitability and efficiency.
- Plant Location: Carbon capture facilities should be strategically located near cement plants to minimize logistics and transportation costs.
- Methanol Production: Annual consumption of methanol in India is approximately 4.2 million tons. Emphasis on maximizing value addition in methanol production through CCUS integration.
- Chemical Looping Technology: Recommendation to adopt chemical looping technology for efficient carbon capture.
- National R&D Centre: Proposal to establish a national research and development center for CCUS, funded through a public-private partnership model.
- Standardization: Need for a taxonomy to standardize the carbon capture industry for consistency and scalability.
- Carbon Financing: Suggestion to develop a detailed framework for carbon financing mechanisms to support CCUS projects and drive investment in the sector.

Dr. Saraswat's insights underscore the importance of a holistic approach, combining technology, logistics, financing, and research, to advance CCUS implementation in the cement industry.

List of Participants:

1. Session Chair: **Dr V K Saraswat – Member, NITI Aayog**
2. Dr Anshu Bhardwaj, Program Director (GT, E&C), NITI Aayog
3. Dr L P Singh, Director General, National Council for Cement and Building Materials
4. Ms Aparna Dutt Sharma, Secretary General, Cement Manufacturers Association
5. Sh Kaustubh Phadke, General Manager, Global Cement and Concrete Association India

(The organising team)

Participants List:

S. No.	Name	Organization
1	Dr Ashok Sonkusare	NITI Aayog
2	Simarjot Kaur	NITI Aayog
3	Ms Naba Suroor	NITI Aayog
4	Dr K K Pant	IIT Roorkee
5	Prof Komal Tripathi	IIT Roorkee
6	Mr Atanu Mukherjee	M.N. Dastur & Co.
7	Dr Supritam Ganguly	M.N. Dastur & Co.
8	Sh Rajshekhar Saha	M.N. Dastur & Co.
9	Sh Vivek Negi	BEE
10	Sh Ashok Kumar	BEE
11	Sh Sandeep Kumar	Power
12	Sh Ajay Kumar Sood	PSA to PM
13	Sh Nitin Srivastava	Greengine
14	Sh Manish m John	Geological Suvery of India
15	Sh Bharat Parmar	Adani Cement
16	Sh Rajshekhar Saha	Dastur Energy
17	Ms Mani Khurana	World Bank
18	Sh Sarvesh Gupta	McKinsey
19	Sh Himanshu Singh	Chakr Innovation
20	Sh Pankaj Kumar	OIL
21	Sh Siddharth Ojha	OIL
22	Sh Vivek Negi	BEE
23	Sh A Pandey	BEE
24	Sh Sharavan Kumar	NITI Aayog
25	Dr Ranjit Rath	Oil India Ltd
26	Sh Nitin Bisht	Oil India Ltd
27	Sh Manish Kumar	Oil India Ltd
28	Sh MM Rath	Shree Cement Ltd
29	Sh Kaustubh Phadke	GCCA India

30	Sh Sharadh	NTPC
31	Sh Surajkant	Chakr
32	Sh Vaibhav Rathi	GIZ
33	Sh Avnish Basaria	Nav Prakriti Geen Energies
34	Sh Akhilesh Bagaria	Nav Prakriti Geen Energies
35	Sh Naveen Ahlawat	Jindal Steel
36	Sh T. Borgohain	OIL India
37	Sh T. Lama	OIL India
38	Sh B Nageswara Rao	NTPC
39	Sh L. P. Singh	NCCBM
40	Sh Nandan Kumar	BIS
41	Sh Jarrar Ahmed	DGH
42	Sh Kuldeep	DGH
43	Sh Bajrang Maheshwari	MHI
44	Sh B M Mahana	CCI
45	Sh Alok Shukla	CCi
46	Ms Devika Wattal	GCCA
47	Sh Karan Singhal	BCG
48	Sh Raju Goyal	Ultratech Cement
49	Ms Kinjal Shah	CRISIL
50	Sh Vikram Vishal	IIT Bombay
51	Ms T S Gouthami	WRI
52	Ms Nimisha V	CSIR-NGRI
53	Sh Brajesh	JK Cement
54	Dr Vasudhara Sen	Thermax
55	Sh Anupam	Dalmia Cement
56	Sh Sebastian Paster	JNCASR
57	Sh Sudhanshu Kr Singh	BEE
58	Sh Manmohan Rathi	Shree Cement
59	Sh Sanjay Banga	Cement Corporation of India
60	Ms Mugdha Deshmukh	CMA

61	Ms S Rawat	ONGC
62	Dr Sanjay Kumar Chattopadhyay	Convener, Dept, of Chemicals and Petrochemicals
63	Sh Sachin Srivastava	BHEL, coal to chemical
64	Sh Rahul B	BHEL
65	Sh Jitendra Kumar Chaudary	BIS, HQ
66	Sh Sandal Agrawal	NITI Aayog
67	Sh Shashi Kumar	ICGEB
68	Sh Amar Shah	W L Gore
69	Sh Milind D	BEE
70	Sh Ajay Agarwal	Shree Cement Ltd
71	Sh Vijay Kumar	Suvian Foundation
72	Sh Sensei Raj	Vision India 2032
73	Ms Sapna Gupta	Anchor
74	Sh Darshak Mehta	ADB
75	Ms Aparna Dutt Shah	CMA
76	Sh K N Rao	CMA
77	Ms Simran Agarwal	CMA
78	Sh Karan Singhal	CMA
79	Sh Anmol Bhallah	CMA
80	Sh Kishor S Kulkan	CSIR-CBRI Roorkee
81	Dr Ravindra Gudi	IIT Bombay
82	Dr Bijan Mondal	BPCL
83	Sh Ashutosh Kumar	NITI Aayog
84	Sh Kanhaiya Lal	NITI Aayog
85	Prof. K K Pant	IIT Roorkee
86	Ms Shreya Doshi	CRISIL
87	Sh Bhaskar Anand	NTPC
88	Dr Sandip	MOES
89	Sh Harsha	NITI Aayog

90	Ms Srishti	NITI Aayog
91	Sh Saksham	NITI Aayog
92	Dr Anshu	NITI Aayog
93	Sh Manoj Kumar	NITI Aayog
94	Sh Rajnath Ram	NITI Aayog
95	Sh Ishtiaque	NITI Aayog
96	Sh VK Saraswat	NITI Aayog
97	Ms Poonam	NITI Aayog
98	Sh Suneel Kumar	NITI Aayog
99	Sh Fayaz Ahmed	NITI Aayog
100	Sh Mahavir	NITI Aayog
101	Sh Ravi Kumar	NITI Aayog
102	Sh Atul Kumar	NITI Aayog
103	Sh Devanshu Vishwakarma	NITI Aayog
104	Ms Anupama Kumari	NITI Aayog
105	Sh Anurag Pandey	NITI Aayog
106	Sh Abhishek Kumar	NITI Aayog
107	Sh Vipul Gupta	NITI Aayog
108	Dr Sunil Kumar	NITI Aayog
109	Sh Chandrabhal Chakrabarty	NITI Aayog
110	Sh Vishal Kumar	NITI Aayog
111	Ms Sapna Bisht	NITI Aayog
112	Sh S Mukherjee	NITI Aayog
113	Sh Prince Tiwari	NITI Aayog

सत्यमेव जयते

NITI Aayog