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Oil Gas & Power

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Exclusive Interview

K Shanmugha Sundaram

Director – Projects, NTPC Limited & Chairman, Central Advisory Board, Power + Coal World Expo 2025

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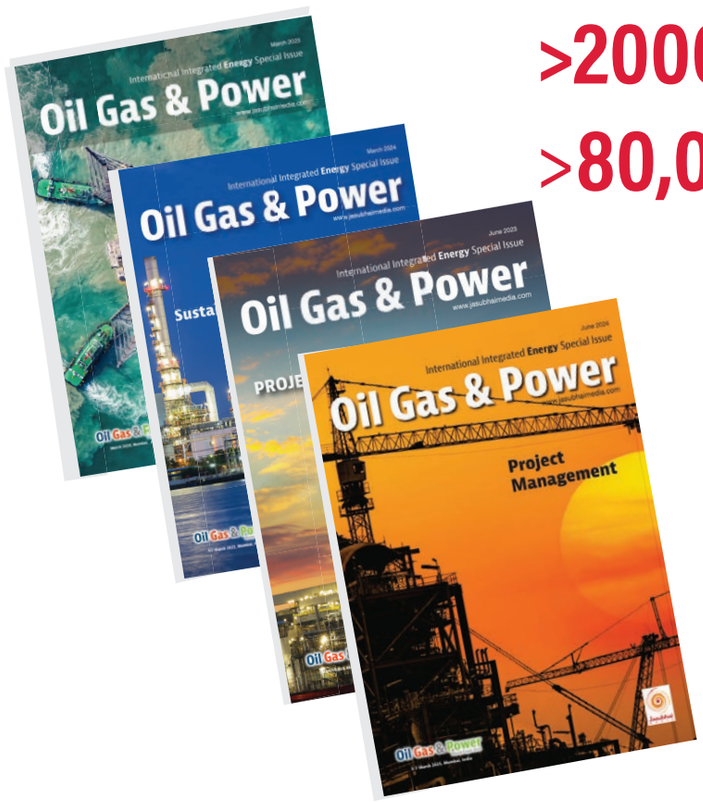

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FEATURE

Dr. Jitendra Singh releases new BioE3 policy

New Delhi, India: Union Minister of State (I/C) Science & Technology, Dr. Jitendra Singh released the path breaking new Bioeconomy policy at National Media Centre in New Delhi. The policy is aimed at 'Fostering High Performance Biomanufacturing' aligned with National initiatives of the government of India such as 'Net Zero' carbon economy and Mission LiFE (Lifestyle for environment).

The Science and Technology Minister said, "BioE3 policy will have a momentous impact on various sectors like food, energy and health." He highlighted the six thematic themes which were Bio-based chemicals and enzymes; Functional foods and Smart proteins; Precision biotherapeutics; Climate resilient agriculture; Carbon capture and its utilisation; Futuristic marine and space research. The Minister underscored that the PPP model will be an intrinsic part of Bioe3 Policy implementation incentivizing industry to promote employment generation.

Cabinet approves amendment in 'Pradhan Mantri JI-VAN Yojana'

New Delhi, India: To keep pace with the latest developments in the field of biofuels and to attract more investment, the Union Cabinet, chaired by the Prime Minister Shri Narendra Modi, recently approved the modified Pradhan Mantri JI-VAN Yojana.

The modified scheme extends timeline for implementation of scheme by five (5) year i.e. till 2028-29 and includes advanced biofuels produced from lignocellulosic feedstocks i.e. agricultural and forestry residues, industrial waste, synthesis (syn) gas, algae etc. in its scope. 'Bolt on' plants and 'Brownfield projects' would also now be eligible to leverage their experience and improve their viability.

The scheme aims to provide remunerative income to farmers for their agriculture residue, address environmental pollution, create local employment opportunities, and contribute to India's energy security and self-reliance. It also supports the development of advanced biofuel technologies and promotes the 'Make in India' Mission. It also helps in achieving India's ambitious target for net-zero GHG emissions by 2070.

V. Satish Kumar takes additional charge as Chairman of IOCL

V. Satish Kumar *has taken additional charge as* ***Chairman of Indian Oil Corporation Limited (IOCL).*** *He will concurrently serve as Chairman while continuing in his role as Director (Marketing), a position he has held since October 2021. He also held the additional charge of Director (Finance) for a period of one year from October 2022, a period characterized by geopolitical tensions due to the Ukraine-Russia conflict.*

With a career spanning 35 years, Kumar has served in various regions across the country and held key positions, leading IOCL's efforts to maintain its leadership in the marketing of petroleum products.

Government approves additional investment in OPaL by ONGC

New Delhi, India: The Government of India has approved the ONGC proposal for additional investment totalling ₹18,365 crores resulting in an increase in ONGC's stake in ONGC Petro-additions Limited (OPaL) from 49.36 per cent to 95.69 per cent. This significant move paves the way for capital restructuring leading to the operational and financial sustainability of OPaL.

OPaL, situated at Dahej in Gujarat, is a world-class petrochemical complex having the largest standalone dual feed cracker in South-East Asia. Commissioned in 2017, OPaL is a state-of-art petrochemical complex with capacity to produce 1.5 MMTPA of polymers and 0.5 MMTPA of chemicals. With 12 per cent market share, OPaL has a good presence in India's polymer segment. The Government's approval to increase ONGC's equity stake in OPaL shall help in rectifying OPaL's capital structure with a healthy Debt Equity ratio. The decision aligns with ONGC's strategic vision to become an integrated global energy major by increasing its presence across the downstream and petrochemical value chain as well.

Minister of Coal issues vesting orders for 10 mines

Mumbai, India: Minister of Coal, G Kishan Reddy, has issued vesting orders for 10 strategically important mines. This initiative, which includes one fully explored and nine partially explored mines, is set to enhance energy security and drive economic growth across the states

of Jharkhand, Chhattisgarh, West Bengal, and Madhya Pradesh. These ten mines have potential to substantially contribute to the nation's energy security and industrial growth. Furthermore, these mines hold a substantial 2395 MT geological reserve, indicating a robust foundation for sustained coal production. These mines are expected to generate annual revenue of ₹166.36 crores and will attract a capital investment of ₹150 crores. They will provide employment to about approximately 1,352 people, both directly and indirectly.

Reddy highlighted the importance of enhancing green cover, adhering to strict safety standards, and actively contributing to the social welfare of local communities, including healthcare, drinking water, and education. He also called on bidders to build strong community relationships and ensure the long-term success of the coal sector through effective environmental conservation practices.

Arvind Kumar assumes charge as Director (Refineries) of IOCL

Arvind Kumar *has assumed charge as* ***Director (Refineries), Indian Oil Corporation Limited (IOCL).*** *Kumar brings a wealth of experience and strategic insight into his new role, following a distinguished tenure as the Managing Director of Chennai Petroleum Corporation Limited (CPCL), a Government of India enterprise and a group company of Indian Oil Corporation Ltd.*

During his leadership at CPCL, Kumar spearheaded numerous significant achievements, including the turnaround of CPCL and Manali refinery, reaching its highest-ever throughput in the fiscal year 2023-24. His strategic acumen was pivotal in enabling CPCL to produce nationally significant fuels such as ISROSENE and JP-7, which are crucial for ISRO and DRDO.

Minister seeks expedition of Lithium mineral exploration in J&K

New Delhi, India: At the Inter-Ministerial meeting of National Mineral Exploration Trust (NMET) held recently, Union Minister Dr. Jitendra Singh raised the issue of J&K Lithium exploration and called for expediting it. In the 6th Governing Body meeting of NMET chaired by G. Kishan Reddy, Minister of Coal and Mines, Dr. Jitendra Singh pursued and sought expediting the exploration of Lithium mineral stores in the district Reasi which promised a quantum leap in the mining economy as well in overall economic growth of India. He also remarked that the exploration work needs to be fast tracked and all the desired help to be provided to meet the deadline. He also referred to the Sapphire Park in Kishtwar which had got delayed.

Dr. Singh urged all the State Government ministers present during the event to utilise the opportunities available and NMET as it is providing 100 per cent support for both infrastructure development and funding for mineral exploration projects.

NHPC REL, TPREL join forces to solarize India

New Delhi, India: In a significant milestone towards harnessing the power of renewable energy, NHPC Renewable Energy Limited (NHPC REL, a wholly-owned subsidiary of NHPC Limited) and Tata Power Renewable Energy Limited (TPREL) have entered into a strategic partnership to implement Rooftop Solar Projects (RTS Projects) on the government buildings of Central Ministries, States, and UTs, under the ambitious PM Surya Ghar Yojna Scheme aiming to achieve 100 per cent solarisation of government owned buildings by December 2025. This collaborative effort aims to transform the energy landscape of India, promoting a cleaner and greener tomorrow, by utilising the available rooftop space on government buildings.

A Memorandum of Understanding (MOU) to this effect was signed on July 17, 2024, at NHPC Office Complex, Faridabad.

Ministry of New and Renewable Energy (MNRE) has designated NHPC Limited as a Scheme Implementing

Rajesh K. Dwivedi appointed Director (Finance) of BHEL

***Rajesh Kumar Dwivedi**, 56, has assumed charge as **Director (Finance)** of the Maharatna Public Sector engineering and manufacturing enterprise, **Bharat Heavy Electricals Limited (BHEL).** He is a distinguished Fellow Member of the Institute of Cost Accountants of India and also holds a Master's degree in Business Administration (MBA).*

Dwivedi joined BHEL as Executive Trainee (Finance) in 1992 and brings with him rich and diverse experience of more than 32 years across various verticals encompassing business strategies, manufacturing and project construction in the power sector along with Board level exposure of holding additional charge of Director (Finance) in Heavy Engineering Corporation Limited, Ranchi since October 2022.

Partner (SIP) to execute the RTS Projects, which will be implemented through its wholly-owned subsidiary, NHPC-REL. TPREL, a renowned leader in solar power sector, brings its vast expertise to ensure the timely and efficient implementation of these projects.

IOCL announces financial results for Q1 2024-25

New Delhi, India: Indian Oil Corporation Limited (IOCL) reported revenue from operations of ₹2,15,989 crores for the Q1 2024-25 as compared to ₹2,21,145 crores in corresponding quarter of previous financial year. IOCL sold 25.252 million metric tonnes of products, including exports, during the first quarter of financial year 2024-25. The refining throughput is 18.168 million metric tonnes and the throughput of the Corporation's countrywide pipelines network including gas pipelines is 25.811 million metric tonnes.

The net profit for Q1 2024-25 is ₹2,643 crores as compared to ₹13,750 crores during the corresponding quarter of previous financial year mainly on account of reduced refining margins affected by lower cracks in line with the international trends and suppressed marketing margins during the current quarter.

Average Gross Refining Margin (GRM) during the Q1 2024-25 is USD6.39 per bbl as compared to USD8.34 per bbl in corresponding quarter of previous financial year. The core GRM for current quarter after offsetting inventory loss/gain comes to USD2.84 per bbl.

RECPDCL hands over Bhadla-III Power Transmission to Power Grid Corporation

New Delhi, India: REC Power Development and Consultancy Limited (RECPDCL), a wholly owned subsidiary of REC Limited, the Maharatna Central Public Sector Undertakings (CPSU) under the aegis of Ministry of Power, handed over a project specific Special Purpose Vehicle, viz, Bhadla-III Power Transmission Limited to Power Grid Corporation of India Limited (PGCIL) at Gurugram.

PGCIL emerged as the Transmission Service Provider (TSP) through Tariff-Based Competitive Bidding (TBCB) process conducted by RECPDCL, the bid process coordinator, for development of the above transmission project on Build, Own, Operate & Transfer (BOOT) basis.

The project covers augmentation of Bhadla-III PS with 765/400 kV, 2x1500 MVA and 400/220 kV, 2x500 MVA Interconnecting Transformers (ICT) and associated works. The project is targeted for implementation in 18 months.

Vivek C. Tongaonkar appointed as Director (Finance) at ONGC

***ONGC** has announced the appointment of V**ivek Chandrakant Tongaonkar as the new Director (Finance)** on 2 July 2024. Shri Tongaonkar is an industry veteran with over 37 years of professional experience in diverse activities across the energy value-chain. He brings a wealth of experience and a proven track record in financial and managerial leadership.*

Tongaonkar's educational background includes an Engineering Degree from the College of Engineering, Pune, and an MBA in Finance from the Symbiosis Institute of Business Management, Pune. He began his illustrious career with ONGC in March 1987 as an Assistant Executive Engineer (Electrical), where he played a crucial role in the Engineering & Construction Division.

NHPC, SJVN, SECI accorded 'Navratna' company status

R.K. Chaudhary, CMD, NHPC Ltd

Sushil Sharma, CMD, SJVN Ltd

New Delhi, India: NHPC Limited, SJVN and Solar Energy Corporation of India Ltd (SECI) have been accorded with the prestigious status of 'Navratna' company by the Government of India.

R.K. Chaudhary, CMD, NHPC, said, "This is a truly historic moment for the NHPC family and recognition of our remarkable financial and operational accomplishments." He added, "NHPC has been an important player in the Indian power sector and has played a key role in tapping the hydropower potential of the country. We are a complete green power company which has also diversified in wind and solar energy options."

Sushil Sharma, CMD, SJVN, said, "The Navratna status is conferred upon select Central Public Sector Enterprises (CPSEs) that have consistently demonstrated exceptional financial performance and managerial efficiency. The Navratna status not only recognizes SJVN's past achievements but also sets the stage for us to undertake larger projects, form strategic partnerships and contribute more significantly to government's vision of achieving 500 GW of renewable energy capacity by 2030."

Solar Energy Corporation of India Ltd (SECI), a CPSE under the Ministry of New and Renewable Energy has been granted the Navratna status on 30th August 2024 by the Ministry of Finance. SECI is the foremost Renewable Energy Implementing Agency (REIA) of India which is continuously working towards fulfilling climate goals and striving for sustainable development.

GreenH Electrolysis unveils first 1 MW PEM electrolyser at Jhajjar plant

(L to R) Dhiman Roy, CEO and Director, GreenH Electrolysis Pvt. Ltd.; Vinod Agarwal, Chairman and Whole-time Director of GR Infraprojects Ltd.; Romen Rawat, Chief Project Manager/Hydrogen Trainset, Indian Railways and Anselmo Andrade, CEO and Founding Partner of H2B2 Electrolysis Technologies.

New Delhi: GreenH Electrolysis, a joint venture between H2B2 Electrolysis Technologies, and GR Promoter

Nandakumar V. Pillai appointed as Director (Refinery) of MRPL

*The Ministry of Petroleum and Natural Gas, Government of India, has approved the appointment of **Nandakumar Velayudhan Pillai,** Group General Manager (Corporate Strategy) to the post of **Director (Refinery)** on the Board of **Mangalore Refinery and Petrochemicals Limited (MRPL)** for a period of five years from the date of his assumption of the charge of the post, or until further orders, whichever is earlier. Nandakumar is a seasoned refining industry expert with over 30 years of experience. He is a Chemical Engineer and graduated with first rank from Government Engineering College, Thrissur, Calicut University.*

Group, unveiled its first 1 MW PEM electrolyser at its manufacturing plant in Jhajjar, Haryana. The 1 MW PEM electrolyser will be installed at the hydrogen production and refueling station at Jind, Haryana, and will supply hydrogen to India's first hydrogen train under the prestigious Indian Railways' 'Hydrogen for Heritage' initiative. The electrolyser will operate round the clock producing approximately 430 kg/day of hydrogen at a delivery pressure of 40 bar (g) and purity as per ISO 14687, suitable for fuel cell applications. The refueling infrastructure at Jind will also have a 3,000 kg hydrogen storage, hydrogen compressor, and two hydrogen dispensers with pre-cooler integration, allowing for quick refueling of the trains.

Cabinet approves India to join International Energy Efficiency Hub

Delhi, India: The Union Cabinet chaired by the Prime Minister Narendra Modi has approved the signing of 'Letter of Intent' thus enabling India to join the 'Energy Efficiency Hub.'

India will join the International Energy Efficiency Hub (Hub), a global platform dedicated to fostering collaboration and promoting energy efficiency worldwide. Established in 2020 as the successor to the International Partnership for Energy Efficiency Cooperation (IPEEC), in which India was a member, the Hub brings together governments, international organizations, and private sector entities to share knowledge, best practices, and innovative solutions. As a member of the Hub, India will benefit from opportunities for collaboration with other member states, sharing its own expertise and learning from international best practices. Bureau of Energy Efficiency (BEE), the statutory agency, has been designated as the implementing agency for the Hub on behalf of India. BEE will play a crucial role in facilitating India's participation in the Hub's activities and ensuring that India's contributions align with its national energy efficiency goals.

KBC acquires Flaretot Limited

London, UK: KBC has announced its acquisition of Flaretot® Limited, a leading simulation software provider, specializing in the design and evaluation of flare systems for hydrocarbon processing plants. Targeting engineers, safety professionals, and environmental compliance specialists, Flaretot's flare system modeling solution will help track and reduce fugitive emissions.

Once integrated into KBC's software portfolio and backed by KBC's consulting expertise, it will provide greater value. This integration will help companies accelerate their implementation of decarbonization strategies and support the oil and gas industry as it contends with strict environmental regulations and the need to make progress towards net zero goals. Engineers in the oil and gas industry face challenges when accurately simulating and sizing relief valves, flare system networks, and pressure vessels during blowdown events.

OIL appoints Saloma Yomdo as Director (E&D)

***Saloma Yomdo** has assumed the position of **Director (Exploration & Development) at Oil India Limited (OIL).** Saloma is a Petroleum Engineering Graduate from Indian Institute of Technology (Indian School of Mines), Dhanbad. He joined OIL in 1994. Before his elevation as Director (Exploration & Development), he was heading the Exploration & Development (E&D) Directorate of the company in the capacity of Executive Director, overseeing E&D activities across India and overseas. He actively implemented various exploration, development as well as reservoir management practices in OIL's oil and gas fields, addressing challenges and achieving breakthroughs through fit-for-purpose technology and geoscientific studies.*

Tata Power Solar partners with Bank of India

Shivram Bikkina, Chief of Rooftop Business at Tata Power Renewable Energy Limited, and Kuldeep Jindal, GM, Micro, Small, and Medium Enterprises Department

Mumbai, India: Tata Power Solar Systems Limited (TPSSL), a wholly-owned subsidiary of Tata Power Renewable Energy Limited (TPREL) has announced a strategic partnership with Bank of India (BOI), to facilitate easy financing for rooftop solar installations and establishment of Electric Vehicle (EV) charging stations.

This collaboration supports the Government's initiatives to promote rooftop solar installations, targeting a wide spectrum of customers, including residential users under the PM Surya Ghar Yojana, housing societies, and Micro, Small, and Medium Enterprises (MSMEs). Under the PM Surya Ghar Yojana, residential customers seeking to install solar systems up to 3 KW can avail loans up to ₹2 lakh with only a 5 per cent margin money requirement. These loans are offered at an attractive interest rate of 7.10 per cent per annum, are collateral-free, and have a tenure of up to 10 years. For installations above 3 KW and up to 10 KW, loans can be availed up to ₹6 lakh with a 5 per cent margin money requirement. The interest rates for these loans range from 8.3 per cent to 10.25 per cent per annum, and these are also collateral-free with a tenure of up to 10 years.

IIT Bombay, ABB India to set up electrical machines and drives lab

Mumbai, India: The Indian Institute of Technology Bombay (IIT Bombay) has partnered with ABB India to establish a cutting-edge teaching laboratory for electrical machines and drives at the Department of Energy Science and Engineering on its campus. This partnership aims to

REnergy Dynamics appoints Subhash Kumar as Chairman of Advisory Board

***REnergy Dynamics (RED)**, a company dedicated to advancing the renewable sector with a special focus on bioenergy and fostering sustainable energy solutions, announced the establishment of its esteemed Advisory Board. This strategic move brings together industry leaders and experts, including **Subhash Kumar as Chairman of the Advisory Board,** as well as Ramakrishna Y, Supratim Sarkar, and Dr Torben Bonde as members, to guide the company's growth and impact in the renewable energy sector. Subhash brings over 40 years of unparalleled experience in the energy sector, having held distinguished roles such as Chairman and Managing Director at ONGC.*

provide undergraduate and postgraduate students with hands-on experience using modern industrial equipment and prepare undergraduate and post-graduate students for future roles in the fast-evolving energy and industrial sectors while promoting environmental sustainability.

The teaching lab will feature energy-efficient, mechanically coupled electrical machine sets, variable frequency drives (VFDs), and programmable logic controllers (PLCs), focusing on delivering practical training in electrical machines and drives. The laboratory will emulate various industrial applications, including those used in wind turbine generators and electric vehicle drivetrains, ensuring that students understand modern energy systems comprehensively. With support from ABB India, the lab will help foster the next generation of engineers, equipped with the knowledge and skills needed to innovate once they join the industry in the future sustainably.

Oilmax Energy, IIT Bombay to collaborate on R&D

Mumbai, India: Oilmax Energy Private Limited has signed a Memorandum of Understanding (MoU) with IIT Bombay to collaborate on Research and Development (R&D) in petroleum, mining, industrial, and green energy technologies. This partnership aims to create cost-effective, real-world solutions for industries and consumers, with a focus on innovation and sustainability. The collaboration between Oilmax Energy and IIT Bombay will combine IIT Bombay's strong R&D capabilities with Oilmax's industry knowledge. The initial focus will be on developing air conditioning and passive cooling solutions, which can be used in industries such as manufacturing, logistics, IT, and real estate. The first prototype is expected by the end of 2024. The R&D team is currently forming a specialized group of graduates and researchers from IITs across India. As the collaboration grows, more students and resources from IIT Bombay will be involved to further expand innovation efforts.

Patel Engineering, RVNL to collaborate on hydro projects

Mumbai, India: Patel Engineering Limited has signed a Memorandum of Understanding (MoU) with Rail Vikas Nigam Limited (RVNL), a Navratna Central Public Sector Enterprise (CPSE) under the Ministry of Railways, Government of India, which works as the construction arm of the Ministry of Railways. The MoU, marks the beginning of a strategic partnership aimed at jointly executing projects in the field of hydro and other infrastructure projects both within India and internationally. The agreement outlines a framework for collaboration between Patel Engineering and RVNL to leverage each other's strengths and capabilities in pursuing hydro and other infrastructure projects. Under this MoU, both parties will explore opportunities to work together in various capacities. The signing of this MoU signifies a milestone in the collaborative efforts between a private and a public sector to advance infrastructure development in India and beyond. ■

H Shankar assumes additional charge as MD, CPCL

***H Shankar** has assumed **additional charge** as **Managing Director, Chennai Petroleum Corporation Limited (CPCL)** with effect from July 16, 2024. Shankar assumed charge as Director Technical, CPCL and has been a part of the CPCL Board since 1 October 2020.*

He is a Mechanical Engineer and MBA in General Management with an extensive knowledge in business management, strategic planning, and leadership. With over three decades of experience in all facets of refinery operations, he has played pivotal roles in project management, leading numerous large-scale projects from inception to completion.

NHPC to set up Pumped Storage Projects

Mumbai, India: NHPC has signed a Memorandum of Understanding (MoU) at Mumbai with the Department of Water Resources, Government of Maharashtra as per Policy of Government of Maharashtra for development of Pumped Storage Projects (PSPs) in the state. The MoU covers the establishment of PSPs in Maharashtra with a total capacity of 7,350 MW, focusing on survey, investigation, and Detailed Project Report (DPR) preparation, along with the timely implementation as per Central and State Government policies.

The MoU marks a significant step forward in developing PSPs as energy storage solutions in Maharashtra, aligning with the national goals of achieving 500 GW of renewable energy by 2030 and Net Zero by 2070.

SJVN commissions floating solar project

Shimla, India: SJVN (formerly known as Satluj Jal Vidyut Nigam) has successfully commissioned 90 MW Omkareshwar floating solar project executed by SJVN Green Energy Limited (SGEL), a wholly owned subsidiary of the company. On commissioning of the project, total installed capacity of the company stands increased to 2,466.50 MW.

Further, 90 MW Omkareshwar floating solar project is housed in Omkareshwar floating solar park located in District Khandwa, Madhya Pradesh. The project is one of the largest floating solar projects in Central and North India. With commissioning of the project, the company has ventured into floating solar power segment.

The project has been developed at a cost of ₹646.20 crores and is expected to generate 196.5 million units of energy in first year. The estimated cumulative energy generation over a period of 25 years shall be 4,629.3 million units. This project will increase company's revenue by ₹64 crores. Currently, the company's total project portfolio is 56,802.40 MW and the company is executing projects in hydro, pumped storage, thermal and renewable energy sectors.

REC signs MoU to finance projects

Delhi, India: REC Limited has signed MoU with Government of Rajasthan, Department of Finance. As per MoU, REC will provide ₹50,000 crore annually (increased from ₹20,000 crore) to finance projects across power and non-power infrastructure for a period of six years upto 2030 i.e. total value of MoU is ₹3.00 lakh crore.

With this MoU, there is expected to be a rapid increase in projects in Rajasthan related to the state's infrastructure sector, such as power projects, metros, roads and highways, airports, IT infrastructure, oil refinery, steel infrastructure, ports and waterways, fiber optics, telecom, health sector, tourism infrastructure, agriculture and other infra projects. This collaboration underscores REC's commitment to supporting the development of both power and non-power infrastructure in Rajasthan, thereby contributing to the state's economic growth and prosperity.

GAIL, Petron to set up Bio-ethylene plant

New Delhi, India: GAIL (India) Limited and Petron Scientech Inc (Petron) have inked a Memorandum of Understanding (MoU) to jointly explore setting up of a 500 Kilo Tons per Annum (KTA) bio-ethylene plant along with its downstream unit(s) in India, based on bio-ethanol produced in the plant in a 50:50 Joint Venture (JV) mode.

In line with the MoU, GAIL and Petron will jointly undertake feasibility studies to ascertain technical viability and financial prospects of the project. Both the parties endeavour to secure investment approval from their respective management for investment in the project and forming a JV company.

Speaking on the occasion, Rajeev Kumar Singhal, Director (Business Development), GAIL, said, "The MoU signifies a major step towards enhancing sustainable practices and advancing the bio-economy in India. The skills and strengths of both the companies would create a synergy for achieving the objective of MoU. The collaboration between GAIL and Petron is poised to not only foster technological advancements but also drive economic growth and environmental sustainability in India."

IREDA signs MoU with SJVN, GMR Energy for Hydro-electric Project

New Delhi, India: Indian Renewable Energy Development Agency Limited (IREDA) has signed a Memorandum of Understanding (MoU) with SJVN Limited, GMR Energy Limited, and their associated companies for the development and implementation of the 900 MW Upper Karnali Hydro-electric Project in Nepal. This collaboration aims to enhance regional energy security through the development of renewable energy infrastructure.

Pradip Kumar Das, Chairman & Managing Director, IREDA, highlighting the significance of the initiative, said, "Our investment in this important hydropower project underscores IREDA's ongoing commitment to advancing renewable energy initiatives. This collaboration not only accelerates the development of Nepal's hydropower sector but also strengthens regional energy cooperation, supporting our shared goal of sustainable growth."

The project holds strategic importance for IREDA, as it will help harness Nepal's vast hydropower potential while reinforcing IREDA's dedication to renewable energy development.

NREL bags solar project

New Delhi, India: NTPC Renewable Energy Limited (NREL), a subsidiary of NTPC Ltd., is executing a solar project with a capacity of 630 MW at Barethi (District-Chhatarpur) in Khajuraho Lok Sabha Constituency. The project is being built under Engineering, Procurement & Construction (EPC) mode sanctioned by the Ministry of New & Renewable Energy (MNRE) under the Solar Parks scheme.

The land for the development of the project has been transferred to NREL. Notice Inviting Tender (NIT) for EPC Package and Pooling Substation Package have been issued by NREL and tender is expected to be awarded by September 2024. The expected date of completion of the project is March 2026.

SWREL bags new order for PV plant in Rajasthan

Mumbai, India: Sterling and Wilson Renewable Energy Limited (SWREL) has announced that it has received a prestigious new order for the Engineering, Design, Testing and Commissioning of a 400 MW AC / 633 MW DC PhotoVoltaic (PV) plant along with supply and works for a 33/220 kV switchyard to be built at plant for a PV project in Rajasthan.

The total value of works including taxes, levies and duties is approximately ₹550+ crore. Speaking on the order win, Amit Jain, Global CEO, Sterling and Wilson Renewable Energy Group, said, "We are thrilled to receive another large domestic order from a leading private renewable IPP in India. The Indian market continues to grow rapidly and as an established home-grown EPC player we are geared to target this high growth."

"With this order win, SWREL has now achieved around ₹900 crore of domestic order inflows in the second quarter of FY25. This is in addition to the order inflow of approximately ₹2,170 crore seen in the first quarter, and we remain confident of further augmenting this order momentum due to a strong domestic bid pipeline being in place," he further added.

Ohmium sets up PEM electrolyzer gigafactory

Newark, California and Bengaluru, India: Ohmium International has announced the official launch of its new gigafactory in Doddaballapura, just outside of Bengaluru, India. Covering close to 14,000 square meters of production space, the state-of-the-art manufacturing facility is ramping up to ship 2 gigawatts (GW) of fully assembled and tested electrolyzer systems to meet the demands of Ohmium's global project pipeline.

The new gigafactory is Ohmium's second manufacturing facility in India, and its first to bring together key manufacturing, assembly, quality assurance, testing, warehouse and shipping facilities under one roof.

The new gigafactory represents a major USD investment in local real estate, equipment and talent and is part of Ohmium's consistent and growing track record of PEM electrolyzer leadership in India – including Ohmium's historic 400 megawatt (MW) deal with NTPC in 2023, its strategic partnership with Tata Projects in 2024, and its selection for the Ministry of Renewable Energy's first round of Strategic Interventions for Green Hydrogen Transition Incentives.

DGPC, Tata Power to build hydropower project

Kuensel, Dechen Dolkar: Druk Green Power Corporation (DGPC) and Tata Power have entered into a strategic partnership to construct the 600 MW Khorlochhu (earlier known as Kholongchhu) Hydropower Project. DGPC will hold a 60 per cent equity stake while Tata Power will invest 40 per cent. The estimated project cost, including financing charges, is approximately Nu 70 billion, with a construction timeline of five years.

With support from the governments of Bhutan and India, all statutory approvals are in place for construction works to commence immediately. This collaboration builds on the existing partnership between the DGPC and Tata Power in the 126 MW Dagachhu Hydropower Plant in Bhutan. The Chief Executive Officer (CEO) and Managing Director of Tata Power, Dr Praveer Sinha, and Managing Director of DGPC, Dasho Chhewang Rinzin, finalised the Definitive Agreement for the project in Mumbai, India on 29 July 2024.

The Khorlochhu Hydropower Limited will enter into long-term Power Purchase Agreements with Tata Power Trading Corporation Limited, a wholly owned subsidiary of Tata Power, for export of summer surplus power to the Indian market and with Bhutan Power Corporation Limited for domestic power sales during the winter.

JSW Neo Energy bags LoI from GUVNL

Mumbai, India: JSW Neo Energy Limited, a wholly owned subsidiary of JSW Energy Limited, has received Letter of Intent (LoI) from Gujarat Urja Vikas Nigam Limited, for setting up 192 MW grid connected hybrid power project, including an additional 96 MW under the green shoe option. The capacity is awarded against tariff based competitive bid invited for setting up of 500 MW grid connected hybrid power projects (Phase II) along with a green shoe option for additional capacity upto 500 MW.

Besides, the company also received Letter of Award for setting up 300 MW Inter State Transmission System (ISTS)-connected wind-solar hybrid power project from NTPC Limited against tariff-based competitive bid invited for setting 1,000 MW ISTS-connected wind-solar hybrid power projects (NTPC-Tranche-VI). Following this capacity award, the company's total locked-in generation capacity has risen to 16.7 GW, which includes a total locked-in Hybrid capacity of 2.6 GW (including firm and dispatchable renewable energy). ■

"Energy transition and decarbonization is the need of hour to meet global climate targets"

K Shanmugha Sundaram
Director – Projects, NTPC Limited

NTPC is India's largest energy conglomerate. With an installed capacity of over 76 GW, NTPC is steering ahead to be India's largest integrated power company and targets to become a 130 GW firm with diversified fuel mix and a 600 BU company in terms of generation by 2032. In an exclusive interview with ***Mittravinda Ranjan, K S Sundaram, Director – Projects, NTPC Limited,*** *talks about the company's growth plans and net zero ambitions.*

What is the current status of thermal power projects in India, including the number of projects under construction, operational, and planned?

Post Covid, we have seen an unprecedented rise in electricity demand. It is continuously rising; this year peak demand has already touched 250 GW on 30 May 2024. It is clearly evident from the efforts of the Ministry that thermal capacity addition is being pushed hard to meet not only the capacity requirements up to 2032 but also to meet grid requirements arising out of renewable energy addition.

All India: We have more than 28 GW thermal projects (21 nos) under construction. We have 243 GW of operational thermal capacity. Further, to cater the requirement of thermal capacity till 2032, 56 GW of thermal capacity is identified for awarding.

NTPC Group: We have 9 thermal projects of capacity ~11 GW, which are under construction, nearly 69 GW is operational and out of identified thermal capacity, we have already awarded ~6.6 GW till last year and this year we are targeting to award majority of capacity, nearly 09 GW.

What are the major challenges faced by thermal power projects in India today? How is NTPC addressing these challenges to ensure the successful completion of its thermal power projects?

The major challenges are as below:

- Limited vendor availability for main EPC and BOP packages.
- Time required in forest land diversions.
- Non-availability of skilled workforce.
- Delay in right of use / way issues.

In EPC approach, there were only two vendors for execution. Now it is being tackled with our new packaging / tendering philosophy. Further, MOP along with CEA and NTPC, is addressing BOP vendors issue and encouraging them to participate in new thermal tenders.

Forest land diversion / RoW / RoU is a long period process, and all the process are being expedited with the support of Our Administrative Ministry.

Skilled workforce is a major issue which one cannot overcome overnight, for this we have set up many ITI's and skill enhancement centers nearby our projects. Further, training is also provided to work force for honing their skills at our project premises.

Please share insights into incorporation of sustainable practices and technologies by NTPC in the thermal power projects to reduce their environmental impact.

Thermal power plants face various challenges which include conventional and transitional challenges. The transitional challenges include the imperative of decarbonization, running below critical technical minimum load, ensuring flexible operation, which is in addition to the conventional challenges like 100 per cent ash utilization as per the new environment norms, reducing the water consumption and complying with stringent environmental regulations. The flexible operation of thermal plant will majorly impact both the boiler and turbine, leading to reduction in residual life, increase in forced outage and hence reduce the reliability and availability of the plant, heat rate degradation, increase in Auxiliary Power Consumption (APC).

NTPC has taken various initiatives for addressing these challenges. For ash management, various avenues for ash utilization, including cement, bricks, paver tiles, blocks etc. are being explored. NTPC has developed novel products such as non-concrete aggregate (NACA) using bottom ash in place of sand. Further, precast elements and paver blocks have been developed using NACA. As a direct-use material, ash is used for road embankment, filling of low-lying areas, bottom ash mine stowing, and bottom ash sand replacement. Environmental challenges in thermal power generation include the generation of greenhouse gas emissions, SO_2 and NOx emissions, water pollution, leaching, and disposal of by-products such as ash and gypsum. To mitigate the environmental challenges, NTPC is taking various initiatives including installing flue gas desulphurization systems, combustion modification systems, ESP R&M etc. On water conservation side, NTPC has taken several initiatives like introduction of air-cooled condenser (ACC), utilization of STP water, Zero Liquid Discharge (ZLD), which has resulted in reduction of specific water consumption to 2.68 litre/KWh against the norms of 3 litre/KWh at company level.

Further, NTPC has taken several initiatives to decarbonize its thermal power plants which include co-firing of biomass, adoption of High Efficiency and Low Emission technologies (mostly Ultra Super Critical Technology) for new coal-based plants etc. Additionally, the company has pursued renovation and modernization (R&M) initiatives to improve the efficiency of existing plants. R&M-focused efforts on turbine systems have led to significant improvements in heat rates, reflecting NTPC's commitment to continuous improvement and technological advancement. NTPC is also carrying out

significant R&D work for reducing the carbon emissions through carbon capture from flue gases and using the captured CO_2 for synthesis of green chemicals (methanol/ethanol/urea etc.), methanol/low carbon fuel firing in coal plants, methanol firing in gas power plants etc. These low-carbon fuels can replace HFO/LDO being used in coal-based power plants, provide an alternative fuel for gas-based power plants and help in for adoption of a circular economy as well as significantly reduce the imports.

NTPC has successfully commissioned 20 TPD carbon capture plant (from flue gas) in NTPC Vindhyachal. This is a first-of-its kind initiative in India. Along with the carbon capture plant, a 2 TPD hydrogen plant is also being set up for synthesis of 10 TPD methanol from captured CO_2. Further, NTPC is also setting up a CO_2 to generation-4 Ethanol plant at NTPC Lara.

Despite the growing emphasis on renewable energy, what opportunities remain for thermal power in India's energy mix? How is NTPC positioning itself to capitalize on these opportunities, such as through the development of supercritical and ultra-supercritical technologies?

India's power generation is expected to increase manifold considering the expected GDP growth over the next two decades. Both peak load demand and energy requirement are expected to grow at a very rapid pace. The goal of 500 GW non-fossil fuel capacity by 2030 will significantly alter the generation mix. The changing generation mix poses challenges for achieving affordable, reliable and sustainable power considering the intermittent renewables, non-availability of commercially viable large scale storage solutions, grid stability issues etc. Further, supply chain disruptions, lack of indigenous manufacturing facilities, land/ infrastructure requirement may pose some challenges for the fast-paced growth of RE capacity in India.

As per the estimates prepared by the Central Electricity Authority, the peak demand is expected to touch 366 GW in 2032. Accordingly, apart from addition of RE capacity, additional coal-based capacity requirement by 2031-32 is 80 GW including 28 GW which is currently under construction. Out of the 80 GW, NTPC is expected to add around 25 GW of coal-based capacity including 11.1 GW which is under construction, and all these capacities are planned to be commissioned by 2031-32. As part of the above plan, till Sep'24, orders have been placed for 4800 MW of coal-based capacity at Singrauli-III, Lara-II, Sipat-III and Darlipalli-II. Further, tenders have been issued for 8.8 GW of capacity. All the new capacity additions are planned only as brownfield projects using HELE (high efficiency and low emission) technologies (Mostly Ultra-super critical technology). Additionally, a joint venture between NTPC and BHEL will implement a full-scale 800 MW commercial plant using AUSC (Advanced Ultra Super Critical) technology.

What is NTPC's role in India's energy transition towards a cleaner and greener energy future? How is the organization balancing its commitment to thermal power with its investments in renewable energy and other clean energy technologies?

NTPC through its green arm NTPC Green Energy Ltd (NGEL) is engaged in the development of solar, wind and energy storage projects and is also actively pursuing green hydrogen opportunities. The company plans to add renewable energy capacity of 60 GW by 2032 which will be more than 50 per cent of the total installed capacity of NTPC by 2032.

NGEL is an active partner in greening the grid by supplying green energy to various DISCOMS. In addition to catering to the requirements of DISCOMS, NGEL is also catering to the green energy requirements of C&I consumers in their pursuit of Net Zero transitions by offering round the clock solutions. The main theme of NGEL's business is focused on the green value chain and will pursue the opportunities that exist in this chain. NGEL is actively pursuing the opportunities in green chemicals (ammonia, methanol, urea etc) space.

The development of above innovative clean energy solutions with solar, wind and energy storage projects complements with the energy generated from thermal projects thereby meeting the overall energy requirement of the country.

Considering the role that pumped storage can play for integration of renewable energy into the grid, NTPC is actively pursuing 8,900 MW of PSPs across the country. Upper Bhavani PSP (1,000 MW) has been recently allocated to NTPC by Government of Tamil Nadu. Also, NTPC has recently signed a MoU with the Water Resources Department, Government of Maharashtra for the development of the Amba PSP (800 MW) and Kumbhe PSP (1,000 MW). Pumped Storage Project is an economical large-scale energy storage system which is domestically available that can balance excess energy generation from the variable RE sources during non-peak hours and raise grid demand during peak hours to provide stability to Grid and RTC power to consumers.

What do you think about the future of thermal energy in India? The government has announced ambitious plans to establish 100 GW of nuclear energy capacity, which is a clean energy source and could potentially replace coal plants for meeting baseload energy needs.

At present, thermal capacity (55 per cent) is playing a significant role in meeting countries' demand. Despite global shifts towards cleaner energy, coal remains a crucial part of India's energy mix due to its uniqueness in demography, geography and geopolitical situations and it will continue to meet the country's baseload energy demands in decades to come. Till 2032, 80 GW capacity will be added through thermal projects.

The government of India's move towards nuclear energy aligns with global trends where countries are seeking to reduce their carbon footprints while ensuring energy security. Nuclear energy offers a reliable, low-carbon alternative to coal, capable of providing baseload power, which is essential for ensuring grid stability.

Significant capacity addition of nuclear capacity is also planned in next 10 years. At present around 8.2 GW capacity of nuclear is under operational and 7.3 GW capacity is under construction. Further sites for 30 GW capacity has been approved, out of which ASHVINI (JV between NPCIL and NTPC) has been allocated one project of 2.8 GW at Mahi Banswara.

NTPC is also exploring to form a nuclear subsidiary company, for which NTPC is aggressively looking for potential sites. NTPC is targeting to add 20 GW of nuclear capacity by year 2050 through joint venture mode and nuclear subsidiary mode.

What is NTPC's vision for the future of thermal power in India, and how does it align with the government's goal of achieving net-zero emissions by 2070?

Energy transition and decarbonization is the need of hour to meet the global climate targets. However, for a country like India, where per capita energy consumption is a fraction of the global average, ensuring energy security, sustainability and affordability is an equally important aspect. Meeting the energy needs of underserved populations, improving safe and sustainable energy access for the poorest and most vulnerable groups is the first and foremost consideration in India. The electricity requirement in India is expected to grow in tandem with its GDP growth and as per CEA, the per capita consumption is expected to rise to 3000 KWh by 2040. In view of the above and considering the challenges of the Indian scenario, renewables capacity addition alone shall not be enough for ensuring reliability, sustainability, and affordability in future. Therefore, the coal-based plants are expected to remain an integral part of the energy mix in future and decarbonizing these plants shall be essential achieving the COP26 commitments as well as meeting the Indian electricity demand in future.

A comprehensive roadmap along with strong regulatory/ policy framework is required for achieving India's Net Zero emissions targets in a graded manner following a transition path with a focus on the challenges in the Indian scenario. The roadmap shall include strategically utilizing the inefficient plants, increased torrefied biomass co-firing in existing plants, co-firing low carbon fuels, use of high efficiency low emission (HELE) USC (Ultra Super Critical) technologies with biomass firing and carbon capture utilization technologies in new plants etc. This can bring the CO2 emissions to the level of a gas power plant, thereby providing a path for future transition to Net Zero Emission (NZE) targets.

To achieve the net zero emission targets along with reliable, sustainable and affordable power, India's power sector will require a multipronged approach. This includes adding of renewable energy sources, decarbonization of existing thermal plants, use of HELE technologies for new thermal plants, implementing commercially viable storage solutions (including long duration and seasonal energy storage), cyclical operation of gas based power plants, optimization of hydro generation, addition of nuclear power capacity etc. ■

Digitalization: A Survival Strategy and a Force Multiplier for Transshipment Ports

Pushpank Kaushik
CEO
Jassper Shipping

Digitalization is emerging as a crucial solution in India's maritime sector to enhance efficiency and capacity at transshipment ports. This technological advancement promises to revolutionize transshipment port operations, ushering in a new era of streamlined global shipping and trade facilitation, opines ***Pushpank Kaushik, CEO, Jassper Shipping.***

On July 12 this year, India's first transshipment port at Vizhinjam welcomed its inaugural container ship. This significant event marks India's debut in global transshipment, heralding a new chapter in the country's maritime history. With approval from the Ministry of Ports, Shipping, and Waterways, the Adani Group's Vizhinjam Port in Kerala becomes the nation's first deepwater transshipment hub, poised to play a crucial role in the international trade routes.

Vizhinjam Port is set to transform India's logistics landscape. Positioned strategically, it will streamline transshipment traffic and become a key hub for major international trade routes linking the US, Europe, Africa, and the Indian subcontinent, as well as the Far East. Notably, it stands out as India's first automated port, boasting cutting-edge infrastructure and advanced capabilities to handle large vessels efficiently. With state-of-the-art container handling equipment and top-tier automation and IT systems, Vizhinjam Port is poised to redefine maritime operations in the region.

A transshipment port plays a vital role in connecting cargo from its origin to its final destination by acting as a transfer point where goods move between ships. However, these ports often encounter delays caused by logistical challenges, mechanical issues, or limited resources. Weather conditions, customs procedures, and congestion can also disrupt smooth operations, affecting trade flow. To tackle these issues, digitalization is

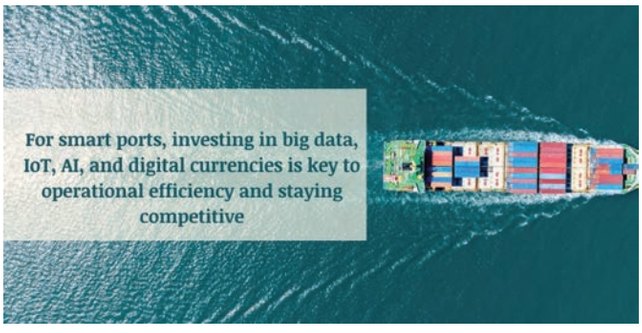
emerging as a crucial solution. In India's maritime sector as well, there is a growing emphasis on digitalization as a pivotal strategy to enhance efficiency and capacity at transshipment ports. This technological advancement promises to revolutionize transshipment port operations, ushering in a new era of streamlined global shipping and trade facilitation.

Digitalization - A Survival Strategy

The digital revolution has emerged in the past decade as one of the main drivers of change in the port and maritime sector. And this helps the industry with:

Government Regulations and Customs - In maritime trade and logistics, regulations and customs visibility involve collaboration between various organizations, including intergovernmental groups, governments, line ministries, and port authorities, along with industry stakeholders. With digitalization, the process speeds up and enables port communities worldwide to meet electronic commerce and data exchange requirements. This ensures compliance with relevant contractual and regulatory obligations, reduces delays, and improves turnaround times, addressing any maritime-related issues effectively.

Enhancing Trade Efficiency - Increasing trade volumes relies heavily on efficient port operations, which are crucial for landlocked developing countries and small island states. Ports lacking automation and facing non-tariff barriers incur higher expenses and hinder trade. A well-functioning transshipment hub, supported by robust hinterland infrastructure, is vital for global connectivity. Efficiency hinges on automated operations, adequate draft and docking facilities, reliable road and rail connections, competitive logistics services, and effective public agency clearance. These elements collectively reduce trade costs, strengthen market competitiveness, and stimulate growth.

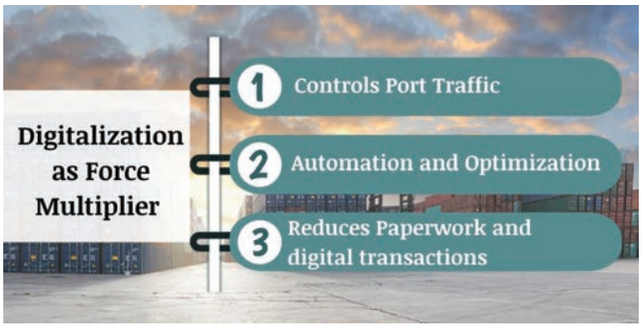


Meets Modern Demands - Shipping lines and supply chain stakeholders are now facing higher expectations from customers for faster turnaround times, improved cargo visibility, and enhanced data exchange. Embracing digitalization offers significant benefits, including real-time operational oversight, spatial context awareness, and comprehensive situational awareness integrated with operational data. Traditional processes and paper-based methods fall short in meeting these modern demands. Digitalized transshipment hubs effectively meet these challenges, enhancing global trade efficiency and simplifying complex manual processes.

Digitalization as Force Multiplier

Automation and Optimization - The Port Community System (PCS) plays a crucial role in streamlining and automating port and logistics operations by centralizing data submission across the transport chain. According to the World Bank, integrating PCS with Port Management Systems (PMS) and MSW3 is essential to maximize digitalization benefits for maritime and trade logistics stakeholders, reducing international trade costs. In India, enhancements like the upgraded PCS, Direct Port Delivery, and Direct Port Entry ensure efficient port operations, supporting seamless data flow and enhancing overall operational efficiency.

Controls Port Traffic - In 2020, the Indian government introduced a new indigenous software solution for Vessel Traffic Services (VTS) and Vessels Traffic Monitoring Systems (VTMS) to manage traffic at Indian ports, replacing costly foreign-made alternatives. VTS enhances maritime safety, navigation efficiency, and environmental protection. Installed in some of the world's busiest waters, VTMS ensures safer navigation, smoother traffic flow, and environmental safeguarding. This system coordinates traffic in approach routes, channels, and harbors, responding swiftly to emergencies. It also stores data for port management, authorities, coastguards, and



search and rescue services. Mumbai Port and Jawaharlal Nehru Port Trust are among many in India employing VTS and VTMS, similar to Singapore's VTIS in the bustling Singapore port.

Reduces Paperwork and Digital Transactions - The FAL Convention aimed to streamline maritime operations by promoting electronic data exchange for ship arrivals, stays, and departures. This move reduces paperwork and minimizes direct human interaction. The use of Port Community Systems (PCS) and real-time tracking helps stakeholders monitor cargo shipments and supports paperless documentation. Digitalization also facilitates smooth online transactions. In 2023, India and Singapore achieved a milestone by piloting the first live paperless transaction on the Trade Trust platform, linking their online payment systems for seamless cross-border trade.

Port leaders embracing the era of smart ports face critical decisions on investing in new technologies like big data, IoT, AI, and digital currency exchanges to boost operational efficiency, documentation, cargo handling, improve maintenance scheduling and enhance competitiveness. These advancements are pivotal for smart port ecosystems but also bring cybersecurity risks that can impact national security. For instance, in Japan, Nagoya Port experienced a cyber intrusion by Russian hackers using Lockbit 3.0 in 2023.

Consequently, port facilities must ensure robust cybersecurity measures not only for their operations but also for visiting vessels. According to the World Bank's

2020 report, ports must comply with the ISPS Code, conducting port facility security assessments (PFSAs) and developing port facility security plans (PFSPs). Updates to PFSPs are required when deploying new cyber-physical systems that significantly alter security protocols. Key ISPS Code elements include threat assessment, preventing unauthorized access, monitoring port areas, ensuring robust communication, incident reporting protocols, maintaining critical operations, and securing cargo handling facilities.

India's first transshipment port is poised to revolutionize global trade dynamics. Equipped with South Asia's most advanced container handling technology, Vizhinjam promises to elevate maritime operations to unprecedented levels of efficiency and sophistication. Upon completion of its automation and Vessel Traffic Management System, Vizhinjam will stand out as a beacon of technological prowess among the world's leading transshipment hubs. This significant leap towards digitalization underscores the growing necessity for global transshipment ports to embrace advanced technologies. However, achieving this transformation necessitates robust political commitment and a comprehensive legal framework spanning maritime, port operations, clearance agencies, and logistics sectors. Moreover, enhancing human capital to meet the demands of digitalization remains crucial for stakeholders to effectively implement these advancements. As Vizhinjam prepares to redefine standards in global maritime trade, its journey exemplifies the imperative of integrating cutting-edge technology into the fabric of modern port operations worldwide. ■

GUEST COLUMN

India's Clean Energy Revolution: Navigating the Path to Sustainable Economic Growth

Amit Jain
Global CEO
Sterling and Wilson Renewable Energy Group

As India prepares for a significant energy revolution, its commitment to clean energy is evident. India's renewable energy sources, including large hydropower, had a combined installed capacity of 195.01 GW by May 2024. With ambitious goals to reduce the carbon intensity of its economy by less than 45 per cent by the end of the decade, achieve 50 per cent cumulative electric power from renewables by 2030, and reach net-zero carbon emissions by 2070, India's path towards sustainable economic growth is set, opines ***Amit Jain, Global CEO, Sterling and Wilson Renewable Energy Group.***

India has set significant renewable energy (RE) capacity targets: 175 GW by 2022 and 450 GW by 2030. This progression underscores the necessity of enhancing domestic production capabilities to meet these ambitious goals. Currently, India is the third-largest energy consumer and holds prominent positions globally in renewable energy installed capacity, wind power capacity, and solar power capacity.

The country's installed non-fossil fuel capacity has seen a remarkable increase of 396 per cent in the last 8.5 years, standing at more than 203.19 GW as of June 2024, which constitutes about 45.5 per cent of India's total capacity. The solar energy sector alone has witnessed a 30-fold increase in capacity over the past nine years, now reaching 85.47 GW. According to the National Institute of Solar Energy (NISE), India's solar energy potential is estimated at 748 GWp. Since 2014, the installed renewable energy capacity, including large hydro, has surged by around 128 per cent.

Investment and Technological Advancements

India's clean energy sector is set to attract substantial investments, projected to reach $250 billion annually. The country aims to commission 500 GW of renewable energy capacity by 2030, contributing over 40 per cent of its incremental electricity generation. This ambitious target places India at the forefront of the global clean energy transition, offering vast opportunities for investment and economic growth.

To meet the growing energy demand, technological advancements are crucial. Initiatives like the National Green Hydrogen Mission, the identification of critical minerals, and the development of floating solar, Agri PV, off-shore wind, and bio-power are steps in the right direction. Expanding the Production Linked Incentive (PLI) scheme to cover the full value chain of solar panels, reversible turbines for pumped storage, and green hydrogen are essential measures. The Ministry of New and Renewable Energy's (MNRE) initiative to supply solar rooftop systems to one crore low and middle income families exhibits policy adjustments to promote clean energy uptake.

Economic Implications and Job Creation

The clean energy sector's potential to drive economic growth and job creation is immense. By 2030, it is estimated that over 1.3 million jobs will be created in the renewable energy space, driven primarily by solar, wind, and bioenergy sectors. Investments in grid infrastructure, energy storage, and electric vehicles (EVs) will further amplify job creation, significantly influencing industrial growth and energy security. The transition to clean energy will not only provide direct employment opportunities but also stimulate ancillary industries, including manufacturing, installation, and maintenance services. The economic multiplier effect of such a large-scale transition is expected to be substantial, fostering regional development and reducing income disparities.

Industrial Growth and Grid Expansion

India's transition to a cleaner energy future necessitates substantial investments in power transmission, renewables and EVs. To meet the rising demand, the country needs to double its installed power capacity over the next decade. This growth will be facilitated by a robust expansion in grid infrastructure, valued at $30 billion by 2030. With the addition of 180,000 kilometers of transmission lines in the past decade, the ongoing government prioritisation of grid expansion will support rapid renewable energy deployment.

The development of a resilient and modern grid infrastructure is essential to integrate the vast amount of renewable energy being generated. Investments in smart grid technologies, grid modernisation, and advanced metering infrastructure will play a pivotal role in enhancing grid stability and efficiency. Moreover, the expansion of transmission lines to remote and rural areas will ensure that the benefits of clean energy reach every corner of the country.

Electric Transportation and Clean Energy Innovation

The electric transportation sector in India is undergoing a significant transformation. The two-wheeler market, in particular, is shifting towards electric vehicles, with penetration increasing from 1.2 per cent in 2021 to 5.2 per cent currently. Government incentives, rising incomes, and expanding charging infrastructure are key drivers of this growth. As battery storage technology becomes more affordable, similar to the solar industry a decade ago, India is expected to witness a surge in energy storage projects.

India's commitment to electric mobility is further exemplified by policies promoting the adoption of EVs

and the development of necessary infrastructure. The Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme has been a key initiative in this regard, offering subsidies for EV purchases and incentivising the establishment of charging stations. This push towards electric mobility is not only reducing reliance on fossil fuels but also mitigating urban pollution and improving air quality.

Role of Policy and Governance

The Indian government has played a crucial role in driving the clean energy revolution through supportive policies and regulatory frameworks. Initiatives such as the National Solar Mission, National Wind Mission, and various state-level policies have provided a conducive environment for renewable energy growth. The emphasis on public-private partnerships and international collaborations has further strengthened the sector. Furthermore, the government's focus on policy continuity and long-term planning has instilled confidence among investors and industry stakeholders. The creation of a robust policy framework that includes incentives, subsidies, and clear regulatory guidelines has been instrumental in attracting both domestic and foreign investments in the renewable energy sector.

Challenges and the Way Forward

Despite the remarkable progress, India's clean energy journey faces various challenges like integration of intermittent renewable energy sources into the grid, financing constraints and land acquisition for large scale renewable projects. It is pertinent to address these challenges by enhancing grid flexibility through advanced technologies, promoting decentralized renewable energy systems and promoting innovation in energy storage solutions. The clean energy revolution is not just about reducing carbon emissions but also about creating a resilient economy, improving public health, and ensuring a better quality of life for all citizens. ■

The Promise of Aneutronic Fusion

Dr. Warren McKenzie
Managing Director
HB11 Energy

Aneutronic Fusion promises to be the truly long-term solution to a global industrial economy powered by clean energy. **Dr. Warren McKenzie, Managing Director, HB11 Energy,** shares more details about this emerging technology.

The quest for a sustainable energy source that can scale with ever-increasing global demand has driven innovation for decades. As the world grapples with crises of climate change, environmental degradation, and energy security, aneutronic fusion has come into the spotlight, promising abundant energy without the pitfalls of radioactive waste, heavy resource and land use, and pollution. Unlike uranium-based fission or tritium-fueled fusion systems, aneutronic fusion isn't just another stepping stone— it promises to be the truly long-term solution to a global industrial economy powered by clean energy.

And yet, aneutronic fusion is not yet the mainstream option for investors and developers. The appeal of easier-to-achieve (though still profoundly impressive) lab results and the historical technology overlap with national nuclear weapons programs have led to an enduring focus on tritium-based fusion.

Nonetheless, it is expected that aneutronic fusion will become the focus of private and public efforts. This will be driven by needs and by capabilities: Needs, because for fusion to power the global economy it must be globally deployable; and capabilities because the exponential improvement in laser cost and performance is rapidly bringing fusion-level performance into practical reality.

Understanding Aneutronic Fusion

Fusion, the process that powers stars, involves combining atomic nuclei to release energy. Traditional fusion research has predominantly focused on the deuterium-tritium (D-T) reaction, two isotopes of

The team from HB11 Energy during an experiment in Osaka.

Hydrogen which when fused together produce enormous amounts of energy, a significant part of it carried by highly energetic neutrons. These neutrons pose several challenges: They induce radioactivity in reactor materials, create waste disposal challenges, shorten operating lifetimes, and necessitate extensive shielding for safety. Costs are very high.

Aneutronic fusion, in contrast, avoids these issues. The 'p-11B' fusion reaction, which involves fusing a proton (Hydrogen nucleus) with a Boron-11 nucleus, produces three alpha particles (Helium nuclei). It produces no neutrons in the primary reaction, hence the term 'aneutronic.' A small number of neutrons can be generated through secondary reactions – p-11B fusion generates 10,000 times less neutron radiation and compared to D-T fusion, and 100,000 times less than Uranium fission, per unit of energy released.

The absence of neutron radiation in the primary reaction is a significant advantage, as it simplifies reactor design, reduces costs, and eliminates long-lived or large volumes of radioactive waste. One day's volume of radioactive waste from D-T fusion is comparable to fully 30 years of waste for p-11B fusion.

This reaction, however, is more challenging to achieve than D-T fusion. It requires a significantly higher concentration of energy in the fuel to initiate and sustain fusion. This is due to the greater Coulomb barrier that must be overcome to for fusion to occur. This is indeed a formidable challenge of physics, engineering and computer science.

A trade-off is evident. The physics of aneutronic fusion is harder to achieve, but the engineering, political, and safety requirements are orders of magnitude simpler. Aneutronic fusion becomes the inevitable choice for global deployment of fusion power.

Hydrogen-Boron: The Optimal Fuel

Hydrogen and boron are both abundant and widely accessible. Far more abundant than Uranium and without related geopolitical constraints, Boron is non-toxic, non-radioactive, and easy to handle and transport. This contrasts sharply with tritium used in D-T fusion, which is radioactive, scarce, and requires a complex and expensive cryogenic supply chain. Tritium is also subject to extensive security controls given its nature, making it difficult to deploy the technology outside major economies.

The p-11B reaction also offers a dramatically simplified fuel cycle. D-T fusion requires continuous tritium breeding (which consumers Lithium in a nuclear reaction) and tritium handling, adding extreme complexity to any D-T fuel power plant. p-11B fuel is stable at room temperature, non-hazardous for human handling (in fact, Boron is sometimes used as a food

supplement), and does not embrittle reactor walls. Jointly, these advantages reduce the scale operational complexity and cost very significantly, opening a path to economic sustainability.

Inertial Confinement vs. Magnetic Confinement: Two Main Approaches to Fusion

The two primary methods of achieving fusion—Magnetic Confinement Fusion (MCF) and Inertial Confinement Fusion (ICF)—differ in their approach to creating the conditions necessary for fusion. Both approaches use the same basic fuel materials.

Fusion requires fusion fuels to be held dense enough, hot enough, for long enough in order to produce a net gain of energy. In a simplification, we can describe MCF as 'longer but less dense' and ICF as 'denser but for a shorter time'. Much of fusion technology development considers how to achieve these conditions with the least amount of external energy required, so as to maximise the ratio of energy gain.

Magnetic Confinement Fusion (MCF): This method, exemplified by the tokamak and stellarator designs, uses powerful magnetic fields to confine and heat plasma until fusion conditions are met. MCF has been the focus of much of the world's fusion research, with projects like ITER and Commonwealth Fusion aiming to demonstrate net energy gain from D-T fusion. While MCF is well-understood - tokomaks and stellarators are the most technologically mature fusion configurations - it faces fundamental challenges due to the high complexity of the machines, especially when tritium is used as a fuel. High temperature superconducting magnets are the key enabling technology for MCF approaches to fusion. This is promising technology, also with some applications outside of fusion.

Inertial Confinement Fusion (ICF): ICF uses lasers or other forms of pulsed energy to bring small amounts of fusion fuel to extremely high densities and temperatures, initiating fusion. The National Ignition Facility (NIF) in the United States is the most prominent example of ICF research, and it has made headlines for achieving the first net energy gain from fusion. ICF has the advantage of being more suited to aneutronic fusion, given the particularly high energy density required to initiate and sustain fusion in p-11B fuel.

HB11 Energy's Approach: Proton Fast Ignition

HB11 Energy uses an approach to aneutronic fusion that leverages the strengths of ICF while addressing its traditional challenges. Our method, known as Proton Fast Ignition, uses a two-step process to achieve the conditions necessary for p-11B fusion. This approach reduces the energy required from the laser drivers, which is the key constraint for inertial fusion energy. The whole process occurs in a fraction of a microsecond.

Fuel Compression: In the first step, a nanosecond laser pulse is used to compress a small pellet of p-11B fuel.

Proton Ignition: The second step involves a picosecond laser pulse that generates a beam of high-energy protons. These protons are directed at the compressed fuel, delivering the energy needed to ignite the fusion reaction in a small 'hot spot'. This hot spot propagates through the compressed fuel, using energy from fusion to ignite more fuel rather than relying on the laser drivers alone.

Overcoming Challenges

High-energy Lasers: Progress in ICF depends heavily on cutting-edge laser technology. The broader laser industry's advancements are crucial, driven by sectors including telecommunications and defence, as they contribute to the development of high-energy, efficient, and scalable laser systems necessary for fusion.

This also provides commercial opportunity for laser technology developed first for fusion. One notable example of this is the EUV lithography that emerged from fusion research at the National Ignition Facility. This technology is instrumental in advancing ASML's semiconductor fabrication capabilities, enabling the creation of the next generation of microchips with unprecedented precision.

At HB11 Energy, we utilize these advancements in our Proton Fast Ignition approach, which employs modular diode-pumped lasers. Thousands of these lasers can be combined to deliver the multi-megajoule energy levels required for fusion. The modularity of this approach is helpful because it enables scaled volumes for manufacturing, and resilience in operation of such a plant.

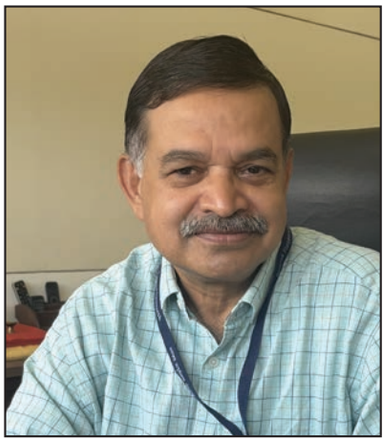
Working with Governments: Collaboration with Governments is essential for advancing aneutronic fusion technology. Government partnerships provide critical research funding and can help validate scientific approaches with the support of national lab research teams. Additionally, regulatory support is crucial for navigating the complex landscape of energy production, ensuring that new technologies meet safety and environmental standards, ensuring public support.

Diversity of Approaches: A significant reason for fusion optimism comes from the increasing diversity of approaches. Governments and private efforts test and push each other with competing approaches. Alongside HB11 Energy, there are significant private companies pursuing aneutronic fusion in China and the US. ENN Fusion, a subsidiary of a major Chinese energy company, is pursuing p-11B energy in a spherical tokomak configuration, with projects in ICF and reverse field configuration also. TAE of the United States, one of the original private fusion companies, uses a field-reversed configuration. Blue Laser Fusion of Japan and the US is pursuing p-11B fusion with a fast-ignition approach.

Conclusion

While the physics and engineering challenges remain significant, aneutronic fusion represents the bridge from fusion science to industrial transformation. It represents truly sustainable baseload energy, globally deployable, safe, and singularly suitable to scale. Collaboration between fusion developers and industry will be critical to speed and smooth practical adoption. High-power laser technology is a central story; the growing laser industry brings fusion closer, and fusion research supports laser applications in many other sectors. A global effort can bring forward a new era of sustainable energy abundance, and secure significant economics for contributors and customers alike. ■

Potential of Fusion Energy: A Look at Indian Contribution to ITER



Ujjwal K. Baruah
Project Director, ITER-India, Institute for Plasma Research[1], Gandhinagar

India aims to be a developed country by 2047 but with concomitant responsibility towards environment. Development, however comes with larger hunger for energy particularly in the form of electricity. While transition from fossil fuels to renewables is already the trend, some deficiencies apart, baseload generators would continue to co-exist the renewable generators playing significant role in the electricity grid in any foreseeable future. Government of India has already announced significant plans for expansion of nuclear power generation which has negligible carbon footprint. Unwavering R&D is the key pillar in the Indian nuclear power generation program, the full potential is yet to emerge, opines **Ujjwal K. Baruah, Project Director, ITER-India, Institute for Plasma Research, Gandhinagar.**

Present day nuclear power generation uses the 'fission', i.e., breaking of heavier atoms to generate energy. There is another atomic reaction called 'fusion' where lighter atoms are fused together forming heavier elements. There is a small loss of mass in the process which appears as energy according to the famous relation $E=mc^2$. In fact, the sun keeps burning its Hydrogen into Helium in fusion reaction and that is the source of almost most of our sources of energy today, fossil fuels or the renewables.

However, the process of fusion is difficult as two atomic nuclei having identical charges together to merge need to overcome the strong coulomb repulsion. This happens only at very high temperature at which the reactants are in a state of plasma, the fourth state of matter (after solid, liquid and gas). Theoretical and experimental studies have proven that the simplest observable nuclear fusion reaction can happen between the nucleuses of 2 isotopes of hydrogen, viz., deuterium (D) and tritium (T) when heated to about 100 Million deg C. The reaction

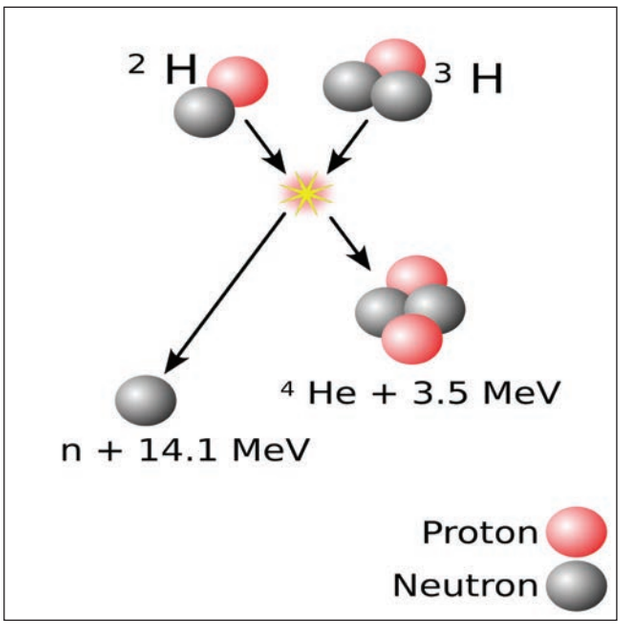


Figure 1: Fusion of two isotopes of Hydrogen generates a Helium nucleus and 17.6 Mev of energy.

between one D and one T nucleus generate about 17.6 MeV of energy (Figure 1).

Theoretically, this translates into about 1.7 million units of electricity hidden in one-gram mixture of D and T gases. The potential energy density is so attractive that even the presently known reserve of naturally occurring deuterium (approx. 0.03 per cent by mass in sea water) would be enough to power the civilization for several hundred million years. Consider this on the backdrop that human civilization is only few thousand years old. It is also understood that we are depleting the fossil fuel reserve at much faster rate than they took to be produced which is several tens of millions of years. It may be pertinent to imagine a sustainable world where energy would be produced either from renewables or from nuclear fusion having its raw materials in abundance and also with zero emission.

Even though the theoretical basis for fusion of hydrogen isotopes was established in laboratories in the early part of the twentieth century, holding a mass of hot plasma in a container and heating the same to the required temperature turned out to be a formidable challenge. In case of fusion reaction occurring inside the sun, its massive gravitational force keeps the hot plasma in place. But any material found on earth would simply melt under the same condition.

A concept of holding plasma in a magnetic bottle, developed by scientists in Russia during late 50s turned out to be the most successful innovation in the field (Figure 2). This concept, named Tokamak, is a toroidal magnetic field created by a set of electromagnets (coils), and the field lines creating the magnetic cage could hold the plasma and heat it for long duration. With better understanding of the underlying science, bigger tokamaks were built in later days. A tokamak (TFTR) in Princeton University, USA could in fact demonstrate fusion reaction in 1992. Similar experiments also conducted in another tokamak named Joint European Torus (JET) in UK could reproduce the fusion reaction. With the ever-improving knowledge about properties of hot plasma and measures for its control, it was realised that a tokamak of much larger dimension would be necessary for realising fusion reaction relevant for generation of electricity.

The engineering of a tokamak large enough for fusion is immensely complex and also expensive. A large part of the components (e.g., superconducting magnets, chamber walls operable at very high neutron flux and temperature, etc.) and auxiliary systems would in fact be first-of-a-kind with many uncertainties. The complexities of the sub-systems and also the desire for convergence of knowledge brought together several countries to form the ITER Collaboration (www.iter.org). Apart from India, the European Union (27 states), China, Japan, South Korea, Russia and the USA are the other

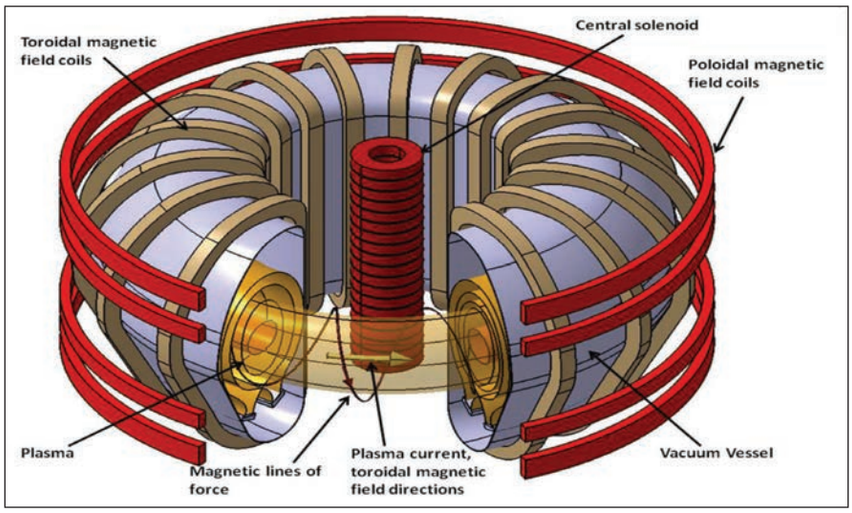


Figure 2: Tokamak, doughnut shaped magnetic bottle created by currents in a set of toroidally spaced coils, other coils are used for stabilization of plasma, etc.

Figure 3: A view from the ITER site in France.

members of this collaboration. The Joint Agreement was signed in November 2006 to establish the ITER facility in Saint-Paul-Lez-Durance in south of France (Figure 3).

In scientific terms, ITER will aim to produce 500 MW of power from D-T fusion with controlled burn of D-T mixture for over 1,000 seconds. If successful, this will pave the way to build a commercial fusion reactor for generation of power in future. Each member in the collaboration contributes 1/11th of the cost of construction except EU, being the host contributing 5/11th of the total. Member countries contribute various components and auxiliary systems as in-kind contribution and also make contribution in cash for operation of the international organization which coordinates, assembles and also responsible for the site. Major systems of ITER are shown in the cut away view (Figure 4), the dimension of the system can be gauged from the approx. 30 m height of the cryostat. More information about the ITER project are available in www.iter.org.

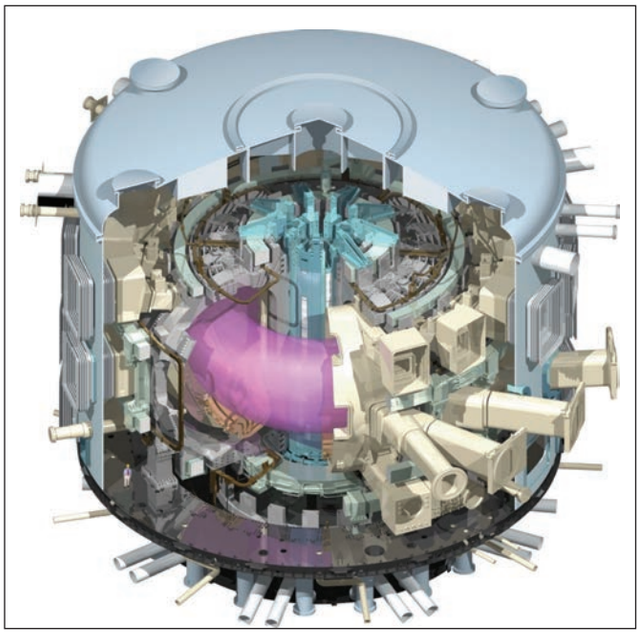


Figure 4: An artist's view of ITER Tokamak, the outer boundary is the cryostat, approx. 30 m tall. Several other components can be seen surrounding the image of plasma (purple).

Indian pursuit for fusion research began in the Institute for Plasma Research, Gandhinagar (www.ipr.res.in) during early eighties. The institute has two smaller tokamaks (ADITYA and SST-1) experimenting on plasma properties, it is also intensely working for development of different technologies necessary for building a fusion reactor. It was pertinent that India too join the ITER collaboration as fusion has the potential to provide a sustainable and environmentally benign source of energy for the development of the country. ITER-India (www.iterindia.in) was created as the special agency to fulfil the Indian commitments towards ITER. Several key components and systems of ITER are contributed in-kind by India.

Figure 5: Manufacturing of base section of Cryostat, the prefabricated pieces were transported from India to assemble this 30 m diameter section weighing above 1,000 tons at a site workshop.

- The Cryostat is a very large vacuum vessel, approx. 30 m tall and 30 m across, is the outer boundary of the reactor. This provided the vacuum necessary to insulate the superconducting magnet coils operating at minus 269°C, also acting as the structural support to the whole tokamak. Approx. 4,000 tons of pre-fabricated sections of various geometry were shipped to ITER site where the final assembly and fabrication was done in a state-of-the-art workshop (Figure 5). The lower part of the cryostat is already installed in its designated place.
- In-wall neutron shield blocks are filled between the two walls of the vacuum vessel to reduce the energetic neutrons generated from the fusion reactions flowing out of the system. These are made of steel with special property for neutron absorption. Over 8,000 blocks supplied from India are being installed in the vacuum vessel by respective manufacturers in EU and South Korea.
- The Cryolines and Cryodistribution system are required for circulation of the liquid Helium (at minus 269°C) and Nitrogen for cooling the superconducting magnets of ITER. ITER has installed the largest Helium liquification plant (75kW cooling power) which is about 100 m away from the tokamak. Over 4 km network of intricate cryolines and the distribution system are being delivered by ITER-India which also helped creating world class indigenous capability in this special technology.
- The secondary Cooling Water System of ITER has a heat removal capacity of over 500 MW (1.2 GW peak), cooled water keeps the Tokamak and its auxiliaries within operating temperature limits. The design to supply of the equipments included over 20 km of trunk and distribution pipelines, large chillers (4.5 MW), cooling towers, control valves, electric motors and drives, associated plant control systems, etc. Delivery of the system meeting stringent engineering and environmental standards of a nuclear site in Europe is another signature of the maturity of engineering capacity in the country.
- High power Radiofrequency (RF) Systems are used to inject several MWs of power into the plasma for heating. Two types of RF systems are contributed by India:

  i. Two sets of RF system operating at 1MW output and 170GHz frequency, a prototype system has been developed to mitigate the technological risk, design has been frozen after successful testing.

  ii. Nine sets of 3 MW, 35-60 MHz range RF systems, for which prototype activities

were initiated for proving the concepts and technologies before finalizing the design.

Works on both these RF systems has created technical competence in respective technology areas within the country.

- Diagnostics Neutral Beam system is another Indian delivery used for injecting accelerated neutral atoms into the plasma and measure the Helium content, a by-product of the fusion reaction. This is a complex system with a large ion source accelerating 60A equivalent of negative hydrogen ions at 100 kV before neutralising and injecting into the plasma. Development of this system has led to the development of several precision metallurgical technologies.

- The Power Supply and Control Systems for the systems mentioned in High power Radiofrequency Systems and Diagnostics Neutral Beam system are also supplied from India. Development and production of these high power (several MW), high voltage (up to 100kV) power electronic systems have started. These systems, unique to fusion and high energy physics applications too have now matured technology within the country.

- Several Diagnostic Systems, using mostly spectroscopic measurement are also delivered by India. Apart from the technical complexity these equipments also need to comply with the harsh exposure to the neutrons generated from the fusion reaction.

The pursuit of in-kind contributions to ITER has been successfully converted into domestic preparedness for construction on an ITER-like system within the country. The collaboration among ITER-India, research organizations and industry has contributed to indigenous development of several technologies including some, where India is not contributing in-kind to ITER. ITER participation has increased competitive competence of manufacturing industry with its exposure to stringent standards and quality norms. Indian industry is also been a significant player in technical services at the international level.

In summary, an energy revolution by the next century is inevitable. With the thrust to achieve net zero to address to global climate concerns and also development, our options in terms of energy sources that hold the potential for being sustainable are quite limited, viz., the renewables and nuclear. All of these have different technological and social challenges. Fusion can be the top contender in terms of raw material availability, safety and long-lasting source of clean and green energy, however, it has probably also turned out to be immensely difficult to get working. But the rewards can be phenomenal. It is prudent to remain aggressively invested in R&D in all areas to enable our future generations with a clean, green and 'lighted' globe. Participation in ITER by manufacturing components involving complex technologies and also having access to the intellectual property and scientific knowledge generated from ITER creates the confidence that commercial scale fusion reactors shall be built in India around the same time as in any other country. The large skill base of scientists, engineers and technicians at industry and institutional level generated by participating in ITER will play an important role in realising the country's future fusion power programs. ■

[1]*Institute for Plasma Research is a Grant in Aid institute of the Department of Atomic Energy, Government of India.*

Making India self-sufficient in radioisotopes and radiation-based products for societal applications

Pradip Mukherjee
Chief Executive
Board of Radiation & Isotope Technology

Board of Radiation & Isotope Technology (BRIT), an industrial unit of Department of Atomic Energy (DAE), was carved out of Bhabha Atomic Research Centre (BARC) to reach the fruits of Research & Development in the field of radioisotopes and radiation technology to the society. On March 01, 2024, BRIT completed 35 years of continuous operation as an independent entity, and have grown into a visible organization, touching the lives of hundreds and thousands of people. In an exclusive interview with ***Mittravinda Ranjan, Pradip Mukherjee, Chief Executive, Board of Radiation & Isotope Technology,*** *shares insights into the technologies developed by BRIT and how BRIT is aligning the future plans to play a pivotal role in India's journey to harness nuclear energy.*

India has a significant population. How is BRIT ensuring the availability and affordability of medical isotopes for the growing healthcare sector? What are the future directions for isotope production and research within BRIT?

Radiopharmaceuticals consist of radioisotopes tagged to suitable carrier molecules and are employed for the early diagnosis of diseases as well as for treatment of diseases, especially cancer. While gamma or positron emitters, such as, ^{99}mTc and ^{18}F, are employed for diagnosis, beta emitters, such as, ^{131}I, ^{177}Lu and ^{90}Y, are used for therapy or treatment of certain disease conditions, including certain Cancers. The medical radioisotopes for use in nuclear medicine are mostly short-lived, with half-life ranging from few hours (for diagnostic radioisotopes) to few days (for therapeutic radioisotopes). BRIT/DAE utilizes radioisotopes that are primarily produced in the Dhruva reactor of BARC. Considering the increasing demand for radiopharmaceuticals in the coming decades, BARC has plans to install and commission new research reactors at Vizag (HFRR and Dhruva 2), so as to maintain the uninterrupted production and supply of radioisotopes from BRIT. In addition, it is also proposed to install a dedicated Isotope Producing Reactor (IPR) for medical radioisotope production in the country. With

the availability of radioisotopes from these reactors, India would be self-sufficient in the availability of radioisotopes and radiation-based products for societal applications. This is expected to completely eliminate the import dependence of radioisotopes in the country.

Apart from their production in nuclear reactor, radioisotopes can also be produced in medical cyclotrons which are useful for PET/imaging and therapeutic applications. BRIT, in collaboration with BARC, had installed 16.5 MeV medical cyclotron in 2002, and, since 2003, BRIT continues to produce and supply ^{18}F based radiopharmaceuticals, such as ^{18}F-FDG, ^{18}F-NaF, ^{18}F-FLT etc. These PET radiopharmaceuticals are supplied to nearby hospitals in Mumbai. BRIT, along with TMC, is in the process of setting up a medical cyclotron at ACTREC, Tata Memorial Centre (TMC), which will augment the ^{18}F-radiopharmaceuticals production and supply in regions around Mumbai.

Another high energy 30 MeV medical cyclotron was installed at Variable Energy Cyclotron Centre (VECC), Kolkata, during 2019. Since 2020, BRIT continues to produce and supply ^{18}F-FDG and ^{68}Ga-based radiopharmaceuticals for PET imaging using this cyclotron. In addition to the popular F-18 and Ga-68 based radiopharmaceuticals, many useful medical radioisotopes, such as I-123, Tl-201, Ge-68, Cu-64, Zr-89, etc., can also be produced in abundance in this cyclotron which will fulfil the need of important medical radiopharmaceuticals requirement of the country. Additionally, the feasibility of production of an important medical radioisotope, Ac-225, useful for targeted alpha therapy (TAT), is also being evaluated, using this facility.

DAE has made vast progress in the radioisotope production/processing technologies. We have recently commissioned Fission Mo-99 processing facility, which can produce medical grade high specific activity Mo-99 which can fulfil the entire country's demand for Tc-99m, the most widely used diagnostic radioisotope. BARC has recently successfully developed laser enrichment technology which is being adopted for enriching stable isotopes like Lu-176 and Yb-176, target materials for producing Lu-177 radioisotope employed for cancer therapy. The development of these technologies will completely indigenize the radioisotope production and cut down the costly target/radioisotope imports reducing radioisotope processing cost considerably ensuring the availability of these important medical radioisotopes at affordable price in the country.

Apart from this, BRIT and BARC are keeping pace with the international developments taking place in the field of radioisotopes and radiopharmaceuticals research. Evolving advanced treatment technologies such as FAPI theranostics, monoclonal antibody and other peptide therapies are being researched and developed for successful translation to the clinic. In days to come, India will not only become self-sufficient in the medical radioisotope/radiopharmaceutical technology, but will be in a position to produce them in abundance to take care of the domestic requirements.

Further, BRIT ensures the availability and continuous supply of another very important radioisotope, Co-60, in the form of high-specific activity teletherapy sealed sources. These are used for radiotherapy to kill cancer cells. This BRIT product has been continuously supplied to all the major cancer hospitals in India, and as per requirement, they are exported.

BRIT has also marketed the technology of producing HDR Brachytherapy source indigenously and is expected to commercially launch the supply by the mid-next year. This will eliminate the import of these sources and thus reduce the cost of treatment of radiation oncology.

Could you elaborate on BRIT's initiatives in utilizing radiation technologies for improving agricultural productivity, food safety and quality? What are some of the most promising applications in this area?

Radiation processing is the controlled application of energy of short wave length radiations of the electromagnetic spectrum, known as ionizing radiations, and, includes gamma rays, accelerated electrons and X-rays, to have desired effect on the product.

Radiation processing is one of the major and effective techniques for improving food safety and overall quality. This includes preventing losses caused by sprouting of bulbs and tubers, ripening and senescence of fruits and vegetables, and insect infestation of grains and pulses and their products during storage. The technology is also used to pasteurize and even sterilize food and allied products for enhancing their shelf life and microbiological safety. It is also being increasingly used to meet sanitary and phytosanitary requirements of international trade and gaining market access for agricultural and horticultural produce.

The food products are processed with radiation in an industrial scale land-based gamma radiation processing

BRIT provides a broad portfolio of products in the form of radiopharmaceuticals, labelled compound and nucleotides, sealed radiation sources, gamma chambers, blood irradiators and radiography exposure devices. BRIT also offers isotope application services, radio analytical services, calibration and dosimetry services and radiation processing services besides project consultancy services for setting up radiation processing plants in the private sector.

Radioisotope production and application of radioisotopes and radiation technology in the fields of industry, healthcare, agriculture and research have made steady progress over the years, thanks to the strong foundation laid down by the experts in the relevant fields and their vision way back in sixties itself.

facility. BRIT helps the interested entrepreneurs in setting up such facilities by providing the necessary techno-commercial information about radiation processing. BRIT happens to be the sole supplier of the radioactive material, Cobalt-60, in the country and ensures the uninterrupted supply of the same. Once set up, BRIT establishes the plant operational parameters of such radiation processing facilities to ensure that the doses delivered to various food products will be within the permissible range. BRIT also provides field training on radiation safety aspects of such facilities to the radiation workers of these facilities.

BRIT has recently launched Low Temperature Irradiator (LTI), which is the facility for processing meat and marine products. The processed products can be preserved at 1-4^{o}C for more than 20 days, without loss of freshness and sensory parameters, without breaking the cold chain.

BRIT is also ready with the prototype 'Mobile Food Irradiator', which is the radiation processing facility for food products 'On Wheels'. This facility can be relocated as per seasonal produce to increase the shelf-life of food products by reducing the microbial load, thereby, reducing post-harvest transportation losses and ensuring food security.

BRIT is not directly involved in various programmes related to agricultural productivity. But it is well known that one of the various methods for crop improvement is genetic modification using gamma radiation. BRIT has supplied laboratory scale gamma irradiator, GAMMA CHAMBER, to various institutes involved in agricultural research.

Apart from these, Radio Analytical laboratory (RAL) of BRIT provides services for the measurement and certification of man-made radionuclides present in food items. Radioactivity Test certificate, which assures this particular quality parameter, is a mandatory document required for the export of food items to many countries. By carrying out this service, BRIT/DAE promotes the export of food items to various countries.

How is BRIT addressing public concerns and misconceptions about nuclear technology? What strategies are in place to enhance public awareness and acceptance of nuclear applications?

Public Awareness and Media Interaction Division (PA&MID) of Department of Atomic Energy is a complete dedicated department, which is responsible for addressing public concerns, conceptions and misconceptions about nuclear technology. Apart from this, there are divisions in Bhabha Atomic Research Centre (BARC/DAE), which are responsible for reaching public through various awareness programmes and website releases about various applications of radiation in varied fields, nuclear safety, environment monitoring and nuclear reactors etc. There are hard bound books, namely, Radioisotopes, Radiation, Health and Society, Atoms for Peace etc. released from time to time by BARC and DAE, so as to enhance public awareness. Also, there are various e-book releases about 'Nuclear Technology', where BRIT also takes part in the relevant sections. These may be checked on the BARC and DAE websites, while enlightening the general public, for the acceptance of nuclear applications.

BRIT/DAE, on a regular basis, also carries out public outreach programmes by way of conducting exhibitions, conferences, lectures, training programmes, arranging facility visits etc., so as to address public concerns. During such programmes, the benefits of radiation and radioisotope-based technologies, and, various applications in Industry, Healthcare, Food Safety and Research, are explained to the public. Training is imparted to University students through various workshops which

are conducted, either along with BRNS/DAE, BARC/DAE etc., or when the students of various fields of Science and Technology undergo training as a part of the respective University curriculum.

Given the international nature of nuclear research and development, how is BRIT collaborating with global partners? What are the key areas of cooperation, and how do these collaborations benefit India?

Cobalt-60 radioisotope, in the form of sealed source, is used in the radiation processing plants, world over, for radiation processing of various commodities and sterilization of medical products. Currently BRIT is one of the key suppliers of Co-60 in the international market for Radiation Processing Plant (RPPs) across the world. BRIT also caters to other international requirements of Co-60 teletherapy source and other sealed sources on a regular basis.

In addition, BRIT provided radiation technology-based equipment such as blood irradiators, gamma chambers, etc., to selected countries. BRIT is also planning to collaborate with certain countries for the supply and procurement of medical radioisotopes on mutual agreement basis. Radiopharmaceuticals based on radioisotopes such as Ac-225, Tb-161 etc. have emerged in the international arena as promising agents for cancer treatment. However, the availability of these radioisotopes is currently restricted to few global producers in the world. Hence international collaborations enabling procurement of these radioisotopes will propel India towards advanced research related to newer radiopharmaceutical development ensuring early clinical deployment of potential technologies for cancer care in the country.

Recently BRIT collaborated with Los Alamos National Laboratory for the repatriation of spent sources to USA. ■

Leveraging Digital Transformation in Oil and Gas Sector

The oil and gas industry is poised for transformative growth through strategic innovation and digitalization. **K. R. D. Srinivas, Chief Digital and Information Officer, Nayara Energy,** throws more light on the various sector-specific strategies for maximizing value creation.

In an era of unprecedented change, the oil and gas industry finds itself at pivotal crossroads. Global energy markets are undergoing a seismic shift, driven by a complex interplay of technological advancements, geopolitical tensions, and mounting environmental concerns. As the world grapples with the dual imperatives of energy security and decarbonization, traditional oil and gas companies face a myriad of challenges that threaten long-established business models.

The energy transition is pushing the industry towards cleaner alternatives, while price volatility complicates strategic planning. Mounting Environmental, Social and Governance (ESG) pressures demand more sustainable practices, and a talent crunch threatens operational continuity. A shifting regulatory landscape, alters interdependencies as technological disruption simultaneously offers opportunities and risks. Meanwhile, evolving consumer behaviour also continues to reshape traditional demand patterns. These challenges are compelling industry leaders to fundamentally rethink their long-term strategies, operational models, and value propositions in an increasingly complex and dynamic global energy market.

Despite facing numerous such challenges, the oil and gas industry is poised for transformative growth through strategic innovation and digitalization. Key opportunities include leveraging digital technologies for operational excellence, diversifying into clean energy sectors, optimizing supply chains with emerging technology, maximizing asset value through digitalization, leading in sustainability, expanding into new markets, and forging strategic partnerships. These opportunities represent a paradigm shift for the industry, offering pathways to resilience and growth.

Upstream Sector

In the high-stakes arena of upstream oil and gas, digital transformation is revolutionizing traditional approaches to exploration and production. This sector, known for its inherent risks and potentially lucrative rewards, is embracing cutting-edge technologies to navigate its complex challenges. Industry leaders are harnessing the power of advanced predictive analytics to mitigate risks, leveraging AI-enhanced decision support systems to optimize capital expenditure, and deploying IoT-enabled real-time monitoring to achieve operational excellence.

The results of these digital initiatives are nothing short of transformative. Best-in-class operators are reporting remarkable improvements across their value chain. Machine learning algorithms are reshaping seismic interpretation, slashing exploration risks significantly. The implementation of digital twins for asset optimization has proven to significantly increase the production efficiency. Furthermore, the adoption of blockchain-enabled smart contracts can streamline joint venture operations, resulting in a reduction in cycle times.

However, success in this digital frontier requires a nuanced approach. Upstream players must carefully balance their digital investment portfolio, judiciously combining quick wins with long-term strategic initiatives. This balanced strategy ensures immediate gains while positioning companies for sustained competitive advantage in an increasingly digital future.

Midstream Sector

The midstream sector of the oil and gas industry, characterized by its asset-intensive operations and predictable workflows, is leveraging technology to unlock unprecedented levels of operational efficiency and value creation.

Asset Integrity Management 2.0 in midstream oil and gas revolutionizes pipeline operations through advanced technologies. It integrates predictive maintenance, real-time monitoring, and AI-driven analytics to enhance safety and efficiency. Digital twins and risk-based inspections optimize resource allocation, while IoT sensors and mobile solutions enable rapid response to potential issues. Drones play a crucial role in midstream pipeline safety by conducting rapid, high-resolution aerial inspections of extensive pipeline networks, detecting leaks, third-party interference, or environmental threats efficiently and safely, especially in hard-to-reach areas. This evolution allows midstream operators to proactively manage their infrastructure, reducing risks and improving overall performance across the pipeline network lifecycle.

However, to maintain their competitive edge in this rapidly evolving landscape, midstream operators must look beyond isolated digital projects. The key to sustained success lies in building a robust digital foundation that can support and accelerate future innovations. This foundation must prioritize seamless data integration across systems and emphasize robust cybersecurity measures to protect critical infrastructure. By focusing on these fundamental enablers, midstream companies can position themselves not just to adapt to the digital future, but to actively shape it, unlocking new levels of operational excellence and value creation in the process.

Downstream Sector

The downstream sector of the oil and gas industry is undergoing a profound digital metamorphosis, one that extends far beyond mere operational enhancements. In this customer-facing segment, digital transformation has become a strategic imperative, essential for maintaining market relevance and driving growth in an increasingly competitive landscape.

First, hyper-personalized customer engagement is revolutionizing how companies interact with and serve their end-users. Second, AI-powered demand forecasting and inventory optimization are bringing unprecedented precision to supply and demand management. Third, smart refinery operations are leveraging advanced technologies to boost efficiency and reduce costs. Finally, agile supply chain management is enabling companies to respond swiftly to market fluctuations and customer needs.

However, to fully capitalize on these opportunities, downstream players must think beyond isolated digital initiatives. The future belongs to those who can pivot towards a platform-based business model, leveraging digital ecosystems to create new sources of value. This shift requires a fundamental reimagining of traditional business structures, fostering collaboration and innovation across the entire value chain.

As the downstream sector continues to evolve, those companies that can successfully navigate this digital transformation will not only enhance their operational efficiency but also forge deeper, more meaningful relationships with their customers.

Sector-Specific Strategies for Digital Success

As the oil and gas industry embraces digital transformation, success hinges on tailoring strategies to the unique challenges and opportunities of each sector:

Upstream Sector

In the upstream sector, digital success revolves around de-risking exploration and maximizing production efficiency. Key strategies include:

- Implementing advanced Artificial Intelligence (AI) and machine learning algorithms for more accurate subsurface modelling and reservoir characterization.
- Deploying IoT sensors and edge computing for real-time well monitoring and predictive maintenance.
- Utilizing digital twins to optimize field operations and enhance production rates.
- Leveraging blockchain for transparent and efficient joint venture management.

Upstream players should prioritize projects that directly impact exploration success rates and production volumes, balancing short-term operational gains with long-term technological investments.

Midstream Sector

For midstream operators, digital success revolves around enhancing asset integrity, optimizing logistics and preventing pipeline pilferages. Winning strategies include:

- Implementing AI-driven predictive maintenance systems to minimize downtime and reduce operational risks.
- Deploying advanced analytics for route optimization and capacity planning.
- Utilizing drone technology and computer vision for pipeline inspection and monitoring.
- Implementing blockchain solutions for transparent and efficient supply chain management.
- Leveraging IoT sensors, real-time monitoring systems, and AI powered anomaly detection to combat pipeline pilferages. These technologies can identify unusual pressure drops, flow or vibrations.

Midstream companies should focus on projects that improve asset utilization, reduce operational risks, enhance overall system reliability, and secure their pipeline networks against pilferage attempts.

Downstream Sector

In the downstream sector, digital success is driven by customer-centricity and operational flexibility. Key strategies encompass:

- Leveraging AI and big data analytics for hyper-personalized marketing and demand forecasting.
- Implementing IoT and edge computing for smart refinery operations and energy efficiency.
- Utilizing digital platforms to create new customer engagement models and value-added services.
- Deploying advanced analytics for agile supply chain management and inventory optimization.

Downstream players should prioritize projects that enhance customer experience, improve operational agility, and create new revenue streams through digital services.

Across all sectors, successful digital transformation requires a holistic approach that goes beyond technology implementation. It demands a cultural shift towards data-driven decision-making, continuous innovation, and cross-functional collaboration. Companies must also invest in building digital capabilities, either through upskilling existing talent or strategic hiring. Crucially, effective change management, a focus on people, and comprehensive training programs are essential to drive adoption, bridge skill gaps, and ensure that workforce can leverage new technologies effectively.

By embracing these sector-specific digital strategies, oil and gas companies can not only navigate the current challenges but also position themselves as leaders in the energy markets of tomorrow. The future belongs to those who can harness the power of digital technologies to drive operational excellence, create new value propositions, and lead the transition to a more sustainable energy landscape. ■

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INTERVIEW

Aligning with India's 100 GW nuclear capacity goal

Anil V Parab
Whole-Time Director & Member
L&T Board (Heavy Engineering & Valves)

India aims to produce 100,000 MW of nuclear power by 2047, a massive increase from the current production of over 8,000 MW. The industry is gearing up towards development of required capacities and enabling ecosystem to realize the plan of Indian government to set up targeted nuclear capacity. ***Anil V Parab, Whole-Time Director & Member - L&T Board (Heavy Engineering & Valves),*** *in an exclusive interview with* ***Mittravinda Ranjan****, shares how Larsen & Toubro is gearing up to align with India's 100 GW nuclear capacity goal.*

How is Larsen & Toubro (L&T) expanding its manufacturing capacity and capabilities to meet the anticipated surge in demand for nuclear equipment in India, as the country aims to achieve 100 GW of nuclear capacity by 2047?

In the late 1980s, L&T established globally benchmarked, state-of-the-art A. M. Naik Heavy Engineering Complex at Hazira, on a sprawling 750-acre plot. High-tech facility is designed for the production of critical, large-sized ultra-heavy, complex equipment for the nuclear sector and process plants. This modern coastal complex, located on the banks of the Tapi River near the Arabian Sea, features a load-out quay with no size limitations for transportation. The multi-facility campus includes one of the world's largest integrated special steels and nuclear forge shops with a capacity of 40,000 MT of finished forgings per annum, biggest induction bending machine and capability to manufacture nuclear reactors, safety heat exchanger, large size modules, supercritical power plant equipment, strategic sector needs and process plant critical reactors. This setup offers a combination of high-tech machinery and specialist large nuclear talent pool at a single location, complemented by the

creation of an ecosystem for training, which is critical to maintaining quality and a robust nuclear safety culture.

In the last decade, extensive implementation of Digital Industry 4.0 technology has consistently enabled L&T to create global benchmark as an industry trend setter by delivery of most complex equipment viz. 700 MWe steam generator more than 1 year early; Cryostat for 500 MW ITER project in Cadarache, France 2 years ahead of project schedule. L&T Heavy Engineering maintained its enviable track record of on time delivery even during the pandemic.

L&T has played a pivotal role in the development of all 23 nuclear reactors in India, as a trusted and dedicated partner of Department of Atomic Energy and Nuclear Power Corporation of India Limited (NPCIL), for over six decades. The company has been at the forefront of significant First-of-a-Kind (FOAK) nuclear projects.

The progress of the first end shield earned a performance-based award from NPCIL, further cementing L&T's reputation for efficiency and reliability.

L&T Valves, a subsidiary of L&T, operates a world-class facility in Kanchipuram, south of India, capable of delivering mission-critical valves for the nuclear industry. In addition, L&T's specialized shop in Vadodara manufactures key equipment of exotic materials for strategic sectors, including the nuclear industry.

Since the early 1970s, L&T has been instrumental in constructing several nuclear power plants, starting with the 220 MW Madras Atomic Power Station. L&T's unmatched legacy in constructing the biggest, largest, and tallest structures across India and worldwide demonstrates its ability to scale up. L&T has constructed TAPS 3, 4 (540 MWe) in 60 months from first pour of concrete which is a benchmark for Indian nuclear industry.

Scaling up from the current domestic nuclear power generation capacity of 8.18 GWe to 100 GWe, by 2047 will mean an addition of around 4 GWe per year. This translates to nearly six reactors per year. L&T, with its current facilities and reallocation of resources, is fully geared up to scale up Indian nuclear program to 100 GWe.

What steps are you taking to increase the indigenous content of nuclear equipment manufactured in India? Are there any specific initiatives or collaborations underway to promote domestic manufacturing?

Back in 2009, the company ventured into the nuclear-grade steel melting and forging business in collaboration with NPCIL. This partnership led to the creation of a joint venture, LTSSHF (L&T Special Steels and Heavy Forgings), which has been manufacturing critical pressure boundary forgings for Nuclear Island Equipment since 2012.

L&T has been the champion of 'Make in India' campaign for many decades. L&T has consistently built strong partnerships over the years, by hand holding companies such as ArcelorMittal Nippon Steel, Bharat Forge, Ratnamani Metals and Tubes Limited, MIDHANI, Star Wire, Jindal Steel, NFC and various Micro, Small and Medium Enterprises (MSMEs). Currently local content in 700 MWe Pressurized Heavy-Water Reactor (PHWR) technology is more than 90 per cent. These collaborations have been crucial in meeting the stringent quality requirements of the nuclear sector through domestic manufacturing.

How are you working to localize your supply chain in India, ensuring a reliable and efficient supply of components and materials for nuclear equipment manufacturing?

Quality and nuclear safety culture are paramount in nuclear equipment manufacturing. L&T Fabrication Procedures (LTFPS) have become the industry norm. L&T worked with DAE/NPCIL to evolve standard Quality Assurance plans. L&T developed in-house technologies and 3D thermal hydraulic software, which were denied to India during the nuclear apartheid.

As there is disparity between the efforts/investments, the small business volume and lack of continuity of work, MSMEs/small manufacturers are reluctant to be part of the nuclear supply chain. Hence L&T follows the insourcing delivery model, wherein L&T invests in facilities, workstations and MSMEs bring their workforce. For indigenous manufacturing of raw materials, I have already mentioned L&T's major contribution above. Bulk ordering can attract more industry players and provide economies of scale. With this goal in mind, the

Government of India announced a fleet program in 2017 for 10 nuclear reactors. Unfortunately, progress has been extremely slow. Till date not a single site has reached the milestone of first pour of concrete.

Additionally, inspection services need to be scaled up by certifying authorized agencies to provide round the clock coverage, aligned to industry work schedules. Nuclear manufacturing traditionally involves multiple inspection hold points. Currently, NPCIL is the sole inspection.

How is your company adapting to the rapid advancements in nuclear technology, such as the development of small modular reactors and advanced nuclear fuels? Which new products or services are you developing to support these emerging technologies?

Small Modular Reactors (SMRs) capitalize on the benefits of modular manufacturing, similar to an assembly line. Traditionally, the nuclear industry has faced challenges due to the ultra-heavy equipment, high levels of customization, and the use of highly specialized raw materials with long lead times. Additionally, transporting these heavy components can take months, especially in case of landlocked sites and remote areas. Modularization, which involves breaking down these items into smaller sizes and assembling them on-site like a Lego set, offers significant advantages.

L&T has embraced Industry 4.0, transforming its Hazira manufacturing facilities into world-class, digitally enabled, state-of-the-art shops. This transformation has significantly increased efficiency, like one operator to simultaneously managing multiple Industrial Internet of Things (IIOT) stations increasing productivity.

In addition to partnering with Department of Atomic Energy (DAE)/NPCIL, L&T has signed Memorandums of Understanding (MoUs) with foreign technology providers for SMRs, MMRs acting as a manufacturing technology partner to standardize design and manufacturing processes. Additionally, L&T is forging ties with direct plant owners in foreign countries, and global nuclear reactor and advanced fuel technology owners.

What are the biggest regulatory challenges you foresee in meeting the stringent safety and quality standards required for nuclear equipment in India? How is your company addressing these challenges?

L&T Heavy Engineering and L&T Valves stand out as the only Indian companies to hold the ISO-19443 certification, a nuclear-specific quality management standard that ensures safety and quality throughout the nuclear supply chain. L&T Heavy Engineering is also the sole Indian company with an active American Society of Mechanical Engineers (ASME) N Stamp, boasting a track record of supplying Class-1 Nuclear components to US utilities. Impressively, L&T has undergone three audits by the US Nuclear Regulatory Commission (NRC) without a single violation.

Both ISO-19443 and the N Stamp are globally recognized as the gold standards in nuclear manufacturing, often required by foreign regulators. L&T Heavy Engineering has received accreditation from ASME to use 'N' and 'NPT' stamps for constructing Class 1, 2, 3, and MC vessels, piping systems, storage tanks, core support structures, and shop assemblies. We have trained our engineers in RCC M French nuclear standards as well. Therefore, we are well placed in meeting stringent safety and quality standards. Remarkably, the rejection rate for LTSSHF in nuclear forgings is less than 2 per cent, a testament to the indigenous development of all grades and forging processes.

L&T has maintained these accreditations to stay ahead in nuclear manufacturing and construction. The company remains committed to realizing India's energy security, delivering products that make India proud, and working towards sustainable growth for future generations. L&T continues to be an industry trend setter, proactively deploying innovative technologies and leveraging its legacy of 'One Stop Shop' solution provider, with unique blend of nuclear culture, most advanced digital technologies to provide unmatched unique customer experience. ■

Schneider Electric launches new innovation products

Schneider Electric has launched eight new innovative products and solutions during its recently held multi-city Innovation Day 2024 event in Mumbai. The new products and solutions include MasterPacT MTZ Active (a revolutionary new circuit breaker designed to set new benchmarks for safety, efficiency, and sustainability while ensuring business continuity); BlokSeT Lean LV Switchboard (this next generation of LV switchboard is IOT ready with wireless connectivity and provides 24x7 real time panel health monitoring to ensure enhanced safety and uptime); Wiser 2.0 Smart Home Energy Management Solution (It is built to transform any new or existing home into a smart home in less than 4 hours); Miluz Lara Switches and Sockets (features include USB-type A+C charging ports, voltage surge protectors and connected switches to maximize comfort); Galaxy VXL (It delivers up to 97.5 per cent efficiency in double conversion mode and up to 99% in conversion, reducing the total cost of ownership) and RM AirSeT (combines pure air technology to decarbonise grids while enabling enhanced performance, reliability, and efficiency of distribution networks) and EvoPact HVX-O-MV Breaker (addresses the renewable market to support Government of India's clean energy generation and distribution initiative). ■

Cummins India launches Retrofit Aftertreatment System

Cummins India Limited has launched Retrofit Aftertreatment System (RAS), an innovative clean air solution that allows customers to use their existing CPCBII and CPCBI gensets, and comply with the latest genset emission regulations. This highly efficient and indigenously designed retrofit emission control device effectively reduces Particulate Matter (PM), Carbon Monoxide (CO), and Hydrocarbon (HC) emissions from genset exhaust upto 90 per cent. The product is thoughtfully designed to be compact, providing a space saving solution with minimal operational and maintenance expenses. RAS utilizes Diesel Oxidation Catalyst and Particulate Filter technology and has been type approved by the Automotive Research Association of India (ARAI). ■

SLB launches carbon storage well integrity assessment solution

SLB has launched a well integrity assessment solution that helps carbon storage developers quantify the risks associated with wells at prospective storage sites with previous drilling activity. The new methodology for quantifying the probability and potential impact of carbon leakage helps customers understand the risks associated with each well, informing remediation strategies and ultimately estimating the project's long-term viability. The solution incorporates advanced failure mode effect and criticality analysis to assess potential leakage pathways, well barrier, failure mechanisms and resulting consequences. Using advanced multi-physics 3D modeling, SLB can assess the volume and flow rates of brine and carbon leakage over time to better estimate risk. ■

Torrefaction Technology: Converting MSW into Green Coal

Torrefaction technology is rapidly growing as an emerging technology. Many corporate and private players are realizing potential of this technology. It aligns with the Swachh Bharat Mission and six UN Sustainable Development Goals and not only reduces landfill waste but also lowers carbon emissions for a greener environment. **Saurabh Kumar, Founder & CEO, Keystone Energy Systems and Partner Keystone Greentech**, shares more information about this new technology.

Delhi-based Keystone Energy Systems and PES Engineers recently won the bid for a waste-to-charcoal project from NTPC Vidyut Vyapar Nigam Limited (NVVN), a subsidiary of NTPC Limited, to convert Municipal Solid Waste (MSW) to torrefied charcoal (Green Coal). Keystone, the technology partner for the project, will implement torrefaction technology, which involves the thermal treatment of input in an oxygen-deficient environment, to produce a cleaner, more energy-dense form of charcoal known as 'Green Coal.'

Torrefaction technology

Speaking exclusively to *Oil Gas and Power*, Saurabh Kumar, Founder & CEO, Keystone Energy Systems and Partner Keystone Greentech, explains, "Torrefaction is a lower temperature form of pyrolysis in which the feedstock (MSW/Refuse-Derived Fuel/Biomass/Sewage Treatment Plant Sludge) is subjected to a high temperature low oxygen environment, thereby disintegrating the hydrocarbon chain and producing highly carbonized output (Green Coal)."

The resulting off gas (or Torr gas) is routed back to the combustion system and used to sustain the process. The resulting carbonized product is volumetrically more energy densified, and more water-resistant material. The product also becomes more brittle and grinds more similarly to that of coal.

Waste to Charcoal project

The new Waste-to-Charcoal project is set to change India's waste-to-energy sector with a waste-to-charcoal project near Village Suthani, Sahjanwa, Gorakhpur, Uttar Pradesh.

Saurabh Kumar, Founder & CEO, Keystone Energy Systems and Partner Keystone Greentech

The conventional Waste-to-Energy projects have posed challenges. Saurabh explains, "The conventional incineration-based Waste-to-Energy projects energy in the form of electricity, which is sold to Discoms at an exorbitantly high rate of approximately ₹10 per unit. This is a form of perpetual subsidy being provided to such Waste to Energy plants, which the Discoms are reluctant to pay for, resulting in delayed payments and defaults." He adds that such plants are highly polluting (gaseous and particulate) and to comply with the stringent environmental norms, costly pollution control measures need to be adopted, further resulting in higher cost of production.

Notably in a large country like India, only 12 Waste to Electricity Plants are operational; 08 have shut down due to pollution, feedstock quality and various other reasons[1].

Though bio-methanation-based Compressed Biogas (CBG) plants are gaining acceptance, it poses challenges such as low input capacity, requires logistics to compress and transport the gas to place of utilization and has varying feedstock quality. High degree of segregation is also required for MSW and only the organic fraction of the MSW can be utilized.

Refuse Derived Fuel (RDF) Plant at Telangana.

Waste-to-Charcoal Project

The new waste-to-charcoal project will convert 500 Tons Per Day (TPD) of MSW to Green Coal, providing sustainable energy while addressing crucial waste management issues. The project will roll out in phases, with the first reactor expected by December 2024 and will reach full operational capacity, with three reactors, by September 2025. The coal is ideal for co-firing with traditional fossil fuels in thermal power plants, cement plants and steel plants, among others.

"This project represents a significant leap forward in our mission to enhance waste-to-energy solutions and reduce our carbon footprint. Converting waste into Green Coal addresses two pressing issues: Energy security for an expanding economy and Effective waste management," says Kumar. "As India's energy demands continue to rise, innovative solutions like this are essential. India faces a significant challenge with the growing energy demand and with its increasing volumes of MSW, which often end up in landfills, causing severe environmental and health issues. The Torrefaction plant will tackle both of these issues by converting MSW into Green Coal with a high calorific value," he added.

Torrefaction-based Waste to Energy plants offer various benefits, such as:

- Ultra-low Capital Expenditure (CAPEX) and Operating Expenditure (OPEX).
- Can handle wide range of feedstock with varying qualities.
- Viable at wide range of input capacities from as low as 100 TPD to high of 1,000 TPD or more.
- Provide consistent output quality.
- Output energy is in form of fuel which can be easily sold in open market in form of solid fuel as coal substitute.
- Is clean, green and efficient.
- Is easy to operate and maintain. No special skill set required.

Challenges

There are a few challenges faced during conversion of MSW into torrefied charcoal, such as:

- **Unsegregated Waste:** Extensive machinery needs to be deployed to separate glass, ceramic, non-ferrous metal, stone etc. Coconut shells and tetra packs containing aluminium are other hurdles for which suitable machineries are required.
- **High moisture content:** Especially during rainy season, which consumes considerably high energy to evaporate/dry.
- **Construction and demolition waste and large stone:** Impact of which, damages installed equipment.

These challenges however can be overcome. Having established and continuously operating two plants – one 50 TPD STP Sludge-based and one 100 TPD RDF-based for a considerable period, Keystone has learnt, corrected and improved from the challenges experienced. The company is confident that this will help them to overcome the challenges. "MSW torrefaction is an emerging technology. No practical reference, testimonial, data or study is available. You learn and improve from the challenges faced," he opines.

He observes that the potential of waste-to-charcoal torrefaction industry in India is huge. As per available data, India generates more than 600 MT of agricultural and 60 MT of MSW per annum[2]. Assuming average 30 per cent conversion rate, approximately 200 million tons per annum of green coal can be produced, which is roughly 30 per cent of India's annual coal consumption. Waste-to-charcoal will be a huge step towards achieving carbon neutrality. "Simplicity of the technology facilitates setting up of small capacity decentralized units at village/small town levels, which can be easily operated by Self Help Groups (SHGs)," says Kumar.

"I foresee emergence of many corporate and private players into realizing potential of this technology. The application will extend from manufacturing green coal to green hydrogen/ammonia (from waste) and biochar," he concludes. ■

[1]Source: https://pqars.nic.in/annex/258/AU780.pdf
[2]Source: https://www.researchgate.net/figure/Agricultural-waste-generation-of-the-major-crops-in-India-in-million-tons-year_fig5_355164115; https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2003989

Oil Gas & Power World Expo 2025

Date: 5-7 March 2025

Venue: Bombay Exhibition Centre, Goregaon, Mumbai

Details: The 13th edition of 'International Integrated Energy Show' will bring together the stakeholders of energy ecosystem from the up-mid and downstream of hydrocarbon industry, alternate and new energies, power generation, transmission and distribution and allied sectors.

Organiser: Jasubhai Media Pvt Ltd
Contact: 022-4037 3636
Email: sales@jasubhai.com
Website: www.chemtech-online.com

Chemtech World Expo 2026

Date: 3-6 February 2026

Venue: Bombay Exhibition Centre, Goregaon (E), Mumbai

Details: World meet of the chemicals, petrochemicals, biopharma and process industry in India

Organiser: Jasubhai Media Pvt Ltd
Contact: 022-4037 3636
Email: sales@jasubhai.com
Website: www.chemtech-online.com

23rd National Power Systems Conference

Date: 14-16 December 2024

Venue: IIT Indore

Details: Biennial event brings together professionals from academia, industry, and utilities, fostering the exchange of ideas, knowledge, expertise, and experiences related to the evolving landscape of electric power systems. The theme of NPSC 2024 is: 'Achieving Decarbonized, Digitalized Energy and Electric Transportation Systems.'

Organiser: IIT Indore and WRLDC
Contact: 022 - 28302209
Email: npsc2024@iiti.ac.in
Website: https://npsc2024.in/

India Energy Week 2025

Date: 11-14 February 2025

Venue: Yashobhoomi, Dwarka, New Delhi

Details: Event will convene the global energy industry to address the most pressing challenges facing the sector.

Organiser: Federation of Indian Petroleum Industry, dmg events
Contact: +971 2697 0550
Email: sales@indiaenergyweek.com
Website: www.indiaenergyweek.com

Gas India Expo 2025

Date: 24-26 July 2025

Venue: India Expo Centre, Greater Noida

Details: Will showcase the latest innovative technologies, products, and services within the global gas and allied industries

Organiser: Indian Exhibition Services
Contact: 9811913376
Email: event@ies-india.com
Website: www.gasindiaexpo.com

OSEA

Date: 19-21 November 2024

Venue: Marina Bay Sands, Singapore

Details: Event will see exhibitions and networking opportunities outlining pioneering technologies for the offshore sector's pivotal role in decarbonization.

Organiser: Informa Markets
Contact: +65 9699 8588
Email: benedict.tan@informa.com
Website: www.osea-asia.com

EGYPES

Date: 17-19 February 2025

Venue: Egypt International Exhibition Center

Details: Exhibition to showcase latest technologies, trends, and opportunities shaping oil and gas future.

Organiser: dmg Events
Contact: +971 4 438 0355, **Email:** sales@egypes.com
Website: www.egypes.com

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3-6 February 2026

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Concurrent Events

EPC 2026 | Specialty ChemiCAL | Refining & Petro Chemicals 2026 | Bio Pharma | Industry Automation & Control 2026 | PVF | WaterEX WORLD EXPO 2026 | Surface Engineering Coating & Corrosion WORLD EXPO 2026 | Chlor-Alkali World Expo & Conferences 2026

Scope for ChemTECH World Expo 2026

- Plant Machinery & Industrial Consumables
- Engineering Consultants
- OEMs for Chemicals & Pharmaceutical Processing Equipment
- Metals & Metallurgy
- Bioprocessing Equipment
- Construction Services Providers
- Plant Maintenance Services Providers
- Logistics & Supply Chain Solutions Providers
- Instrumentation & Process Control
- Industry Automation (Process & Factory)
- Systems Integration & ERP Solutions Providers
- Water & Waste Water Treatment Consultants
- Environment Solutions Providers
- Waste Management Consultants
- Financial Institutions
- Fire & Safety Solutions Providers
- Material Handling Solutions
- Certification Bodies
- Welding Solutions
- Quality Health & Environment Solutions
- Analytical & Laboratory
- Packaging Materials, Machinery & Systems
- Business Consultants

Scope for Specialty Chemicals World Expo 2026

- Agrochemicals Intermediates
- Adhesives & Sealants
- Agrochemicals & Crop Protection
- Bulk Drugs & Intermediates
- Enzymes
- Colorants, Dyes & Pigments
- Cosmetics & Personal Care Ingredients
- Hygiene & Cleaning Chemicals
- Laboratory Chemicals
- Surfactants
- Water Treatment Chemicals
- Catalysts
- Electronic Chemicals
- Flavours & Fragrances
- Contract Manufacturers

Scope for Biopharma World Expo 2026

- Materials Processing
- Pharma Machinery
- Pharma Ingredients
- Plant Engineering, Process Plants & Equipment
- Laboratory & Analytical Solutions
- Process Measurement & Inspection
- Sterilization & Clean Room Solutions
- Biopharma R&D And Manufacturing
- IT Solutions
- Water & Waste Treatment Solutions

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- **1500+** BUSINESS DELEGATES
- **2500+** ENGINEERING PHARMA & SCIENCE STUDENTS AT STUDENT OUTREACH PROGRAM FROM 28 STATES & UNION TERRITORIES
- SCALE@CHEMTECH World Expo 2024: 60+ GLOBAL CLIMATE TECH STARTUPS FROM 20 COUNTRIES; 40 TECHNICAL PRESENTATIONS
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Gas World Tech Expo 2025

Concurrent Conferences: Oil & Gas | Natural Gas & LNG | Refining & Petrochemicals | Power & Coal | Nuclear Energy | Green Energy & Hydrogen Shipping, Marine & Ports | Surface Engineering Coating & Corrosion Control | Student Outreach Program

EXHIBITOR GROUPS

OIL & GAS
- Exploration & Production
- Oil Field Services
- Geographical and Seismic Surveys
- Drilling
- Sub Sea
- Transportation Storage & Infrastructure

NATURAL GAS & LNG
- Natural Gas Marketing
- City Gas Distribution
- Transportation & Storage Infrastructure

REFINING
- Oil Refining
- Marketing
- Petrochemicals Manufacturing
- Technology Licensors

POWER
- Power Generation
- Technology Licensors
- Power Transmission & Distribution
- Infrastructure

CLEAN ENERGY
- Renewables – Solar Wind & Hydro
- Hydrogen
- Biofuels
- Methanol
- Nuclear

ENGINEERING SERVICES
- EPC services
- Project Management Consultants
- Engineering Services
- Construction

SHIPPING MARINE & PORTS
- Shipping Services
- Ports
- Inland water ways
- Transportation Warehousing
- Supply Chain Management
- Material Handling & Supply Chain Management
- Logistics Services

CORROSION CONTROL
- Surface Engineering
- New metallurgies
- Industrial Coatings
- Corrosion Control Technologies & Services

PROCESS PLANTS & PLANT EQUIPMENT
- Distillation Columns
- Reactors
- Heat Exchangers, Cooling Towers & Boilers
- Storage Tanks
- Compressors , Pumps & Valves
- Plant instrumentation & automation
- IT Infrastructure & Digital Technologies

FACTS AND FIGURES OIL GAS & POWER 2023

3 DAY TRADESHOW

201 EXHIBITORS & PARTNERS

8897 VISITORS FROM 28 COUNTRIES

192 VIP GUESTS

5 CONFERENCES

853 DELEGATES

147 SPEAKERS

670 ENGINEERING UNDERGRADS FROM 23 C OLLEGES ACROSS INDIA

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