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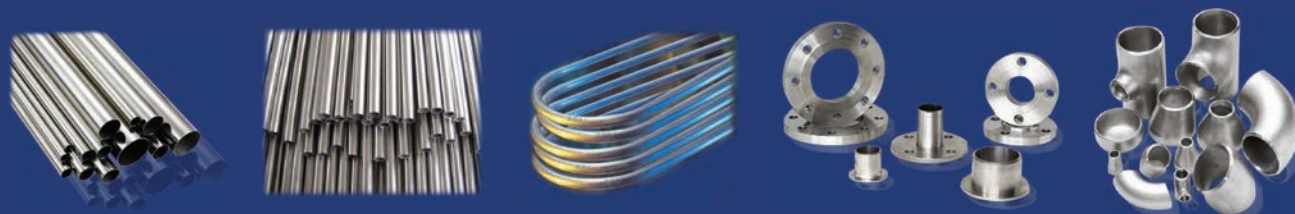
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Raj Clean Energy inaugurates 12 TPD CBG plant in Maharashtra

Satara: Raj Clean Energy, a sustainable energy venture under the aegis of Raj Process, recently inaugurated its 12 TPD Compressed Biogas (CBG) plant and a new research and development (R&D) facility of Raj Process Equipments & Systems Pvt. Ltd. at Ahire, Khandala, Satara. The plant was inaugurated by Hon'ble Shri Nitin Gadkari, Union Minister of Road Transport & Highways, Government of India. His address underscored the pivotal role that CBG and other green energy initiatives will play in strengthening India's energy security and accelerating the nation's transition towards a sustainable future.

The CBG plant will utilize sustainable feedstocks such as Napier grass and pressmud to produce clean and renewable compressed biogas, supporting India's vision of Net Zero, Atmanirbhar Bharat, Make in India, circular economy, and sustainable energy development. Along with the CBG plant, Raj Process also inaugurated its advanced R&D facility, focused on next-generation technologies such as green hydrogen, methane to hydrogen, carbon capture and utilization, sustainable aviation fuel, wax recovery from pressmud, advanced biofuels, and other sustainable industrial technologies.

BPCL and Sembcorp JV secure 10KTPA green hydrogen contract from Numaligarh refinery

New Delhi: Bharat Petroleum Corporation Limited (BPCL), has marked a significant milestone in India's clean energy transition with NeuEN Green Energy Pvt. Ltd. (NeuEN) securing a contract to supply 10,000 tonnes per annum (10KTPA) of green hydrogen to Numaligarh Refinery Ltd. (NRL).

NeuEN Green Energy Pvt. Ltd., a 50:50 joint venture between Bharat Petroleum Corporation Limited (BPCL) and Sembcorp Green Hydrogen India Private Limited, a wholly owned subsidiary of Sembcorp Industries, represents BPCL's strategic foray into renewable energy and large-scale green hydrogen development.

Under the contract, the joint venture will develop a 10KTPA green hydrogen production facility at NRL's refinery in Assam, supported by a long-term offtake arrangement. The project is expected to begin commercial operations in 2028, and will integrate

renewable energy with advanced storage solutions to enable reliable, round-the-clock operations to support refinery decarbonisation.

The project will feature a hybrid renewable-powered configuration integrated with advanced energy storage solutions to ensure reliable and round-the-clock electrolyser operations. This initiative further enhances Northeast India's contribution to national energy security while advancing India's clean hydrogen ambitions.

TrueRE Oriana Power signs ₹3,135 crore green ammonia offtake agreement with SECI



(L - R): Mr. Pankaj Ostwal, Managing Director, Madhya Bharat Agro Pvt. Ltd., Mr. Sanjay Sharma, Director, SECI, and Mr. Anirudh Saraswat, Founder and CBO, TrueRE Oriana Power.

New Delhi: TrueRE Oriana Power, one of India's largest integrated renewable energy companies delivering clean energy solutions across the value chain, has signed a long-term Green Ammonia Purchase Agreement (GAPA) with Solar Energy Corporation of India (SECI). The agreement entails a contracted supply of 60,000 tonnes per annum at a discovered price of ₹52.25 per kg, with a total contract value of approximately ₹3,135 crore over a period of 10 years. The corresponding Green Ammonia Sale Agreement (GASA) has also been executed between SECI and Madhya Bharat Agro Products Limited, the end-offtaker.

TrueRE Oriana Power had received the Letter of Award (LoA) for the project in August 2025 under the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme. The agreement was formalised on March 30, 2026, at a signing ceremony held at Atal Akshay Urja Bhawan, New Delhi, under the aegis of the Ministry of New and Renewable Energy (MNRE). The ceremony was attended by Shri Pralhad Joshi, Union Minister for New and Renewable Energy, Shri J. P. Nadda, Union Minister for Chemicals and Fertilizers and Shri Shripad Yesso Naik, Minister of State for New

and Renewable Energy, Mr. Anirudh Saraswat, Founder and CBO, TrueRE Oriana Power, along with senior officials from MNRE, the Department of Fertilisers, and industry stakeholders. The project, located in Sagar, Madhya Pradesh, will be developed by TrueRE Oriana Power. The company will be responsible for end-to-end execution, including development, approvals, and land-related clearances.

NTPC, Octopus Energy Group sign MoU for co-operation in power & energy sector



Dr. Jatinder Singh Chandok, Head International Business Development, NTPC and Mr. Chris Fitzgerald, Group Director, International Affairs, Octopus Energy, while signing of MoU.

New Delhi: NTPC Limited, India's largest integrated power utility, has signed a Memorandum of Understanding (MoU) with Octopus Energy Group, a leader in clean energy and digital energy platforms, to explore strategic collaboration across the power and energy sector. The MoU was signed in the august presence of Sh. Pankaj Agarwal, Secretary (Ministry of Power, GoI), Sh. Piyush Singh, Additional Secretary (Ministry of Power, GoI), Sh. Gurdeep Singh, CMD, NTPC Limited and Ms. Renu Narang, CEO, NVVN.

The MoU was signed by Dr. Jatinder Singh Chandok, Head International Business Development, NTPC and Mr. Chris Fitzgerald, Group Director, International Affairs, Octopus Energy. The MoU establishes a non-binding framework for cooperation aimed at identifying, assessing, and pursuing opportunities in electricity distribution and retail, renewable energy and storage, electric vehicle (EV) charging infrastructure, digital energy platforms, innovation, research and development and capacity building.

The collaboration will explore opportunities across India, the United Kingdom, and other mutually agreed geographies, with a focus on enhancing efficiency, affordability, reliability, and clean energy adoption.

Thermax secures boiler package supply order for thermal power project

Pune: Thermax Babcock & Wilcox Energy Solutions Limited (TBWES), a wholly owned subsidiary of Thermax, has secured a boiler package supply order valued at approximately ₹1,600 crore from a leading thermal power project company in Central India for a 1x800 MW ultra supercritical thermal power plant.

The scope of work includes manufacturing, supply, supervision of installation and commissioning, as well as performance testing of the boiler package. Execution will be aligned with project milestones and delivery schedules as defined in the contract. TBWES provides equipment and solutions for generating steam for process and power through the combustion of various solid, liquid and gaseous fuels, as well as through heat recovery from turbine/engine exhaust and (waste) heat recovery from industrial processes. TBWES also offers heaters for various applications in the chemical, petrochemical and refinery segments. Its services arm offers renovation and modernisation solutions for old boilers and heater as well as digital solutions for all make.

Premier Energies commissions 5.6 GW solar facility; crosses 10 GW module capacity

Hyderabad: Premier Energies Limited has commissioned its 5.6 GW solar module manufacturing facility at Seetharampur, Telangana, with trial production commenced. Spread across 75 acres, the facility is expected to create approximately 2,000 jobs, boosting local economy and strengthening India's clean energy manufacturing ecosystem. With this capacity addition, Premier Energies' total solar module capacity has now touched 11.1 GW. The new production facility houses one of India's most advanced and highly automated solar module manufacturing lines. This facility can produce four G12R TOPCon high-efficiency modules every 1 seconds. The high level of automation not only ensures precision, consistent quality, and superior throughput, but also reduces operating costs and improves capacity utilization. It incorporates AI-powered fault detection to identify and correct defects in real time, enhancing module reliability and performance.

PROJECT UPDATES

Fluor signs contract with X-Energy for advanced nuclear project in Texas

Irving, Texas: Fluor Corporation has entered into a contract with X-energy to support the company's proposed advanced nuclear project at Dow's UCC



Leaders from Fluor, X-energy, and Dow gathered at Fluor's offices in Houston to kick off the FEL-2 phase of X-energy's advanced nuclear project in Seadrift, Texas.

Seadrift Operations in south Texas. Under the agreement, Fluor will initially deliver Front-End Loading Stage 2 (FEL-2) services. FEL-2 focuses on project definition, strategic planning, feasibility assessment, cost control and risk mitigation.

The X-energy project proposes to develop four, 80-megawatt small modular reactor (SMR) units to supply Dow's Seadrift site with safe, reliable, carbon free electricity and industrial steam, replacing aging energy and steam infrastructure. The project is supported by the U.S. Department of Energy's (DOE) Advanced Reactor Demonstration Program (ARDP), which accelerates the commercialization of advanced nuclear technologies through cost shared partnerships with industry.

X-energy was selected by the DOE in 2020 to develop, license and build its XE 100 advanced SMR and a first TRISO-X fuel fabrication facility. Since then, the company has completed engineering and preliminary reactor design, advanced development and licensing of its fuel facility in Oak Ridge, Tennessee. The Seadrift project is expected to become the first grid scale advanced nuclear reactor deployed to serve an industrial facility in North America.

Hon'ble PM inaugurates OIL's Numaligarh-Siliguri product pipeline capacity augmentation project



New Delhi: The Hon'ble Prime Minister of India, Shri Narendra Modi, inaugurated the capacity augmentation project of the Numaligarh-Siliguri Product Pipeline (NSPL) of Oil India Limited (OIL) during a public meeting held in Guwahati. The Numaligarh-Siliguri Product Pipeline (NSPL) is a 654-km long, 406 mm (16-inch) diameter cross country multi-product pipeline, which was originally designed and operated for a capacity of 1.72 Million Metric Tonnes Per Annum (MMTPA), the pipeline has now been upgraded to 5.5 MMTPA to support the expansion of Numaligarh Refinery from 3.0 MMTPA to 9.0 MMTPA under the Government of India's Hydrocarbon Vision 2030 for the North-East.

The capacity enhancement has been achieved through upgradation of existing infrastructure, including conversion of pigging stations at Sekoni, Guwahati, Bongaigaon and Madarihat into intermediate pumping stations, augmentation of pumping facilities at Numaligarh dispatch terminal and upgradation of facilities at Siliguri receipt terminal for enhanced operational efficiency and safety.

Implemented as a brownfield project, the augmentation has been completed within approximately ₹750 crore against the approved cost of ₹860 crore, achieving substantial savings while optimizing the utilization of existing assets. During the execution phase, the project generated significant employment, with around 4.1-million-man hours over a period exceeding three years across Assam and West Bengal. The project represents a major milestone in strengthening petroleum product transportation infrastructure in the North-Eastern region and enhancing India's energy security. ■

'Anugyan'- India's First Industry-Oriented Nuclear Professional Programme by IIT Hyderabad & Crimson Energy



IITH and Crimson Energy Experts management with Dr. V.K. Saraswat (centre) during the launch of 'Anugyan' training programme

With the rising demand for trained professionals in the nuclear energy sector, IIT Hyderabad, in collaboration with Crimson Energy Experts Pvt. Ltd. (CEEPL), has launched the Nuclear Technology Orientation Programme (NTOP) under the banner 'Anugyan'; a comprehensive, end-to-end nuclear education programme that combines classroom instruction with hands-on simulator training and exposure to design functions. Designed to prepare engineers and professionals for careers in the nuclear industry, the programme has been conceptualised to bridge the gap between academic learning and industry requirements.

Following the enactment of the SHANTI Act, India's civil nuclear sector is entering a transformational phase, paving the way for greater private-sector participation, technology partnerships, localisation and innovation. With the national goal of achieving 100 GWe of nuclear power capacity by 2047, the country is witnessing unprecedented expansion in nuclear infrastructure, creating significant demand for skilled professionals who understand not only the technology but also the

scale, complexity and regulatory framework governing the industry.

Nuclear technology is highly knowledge-intensive and subject to rigorous safety standards. India's growing nuclear programme therefore requires specialised human capital trained in reactor design, engineering, construction, operation and maintenance, radiation protection, waste management and other critical disciplines. Anugyan has been specifically designed to address this need by providing engineers with practical insights into nuclear operations, regulatory frameworks and real-world case studies from India and abroad.

The first offering under NTOP is a three-month fully residential Orientation Programme for Engineers (OPE), commencing on 3 August 2026 at the IIT Hyderabad campus. The residential programme will be delivered by IIT Hyderabad faculty, industry veterans and distinguished scientists and engineers from BARC, NPCIL, NFC and BHAVINI. Participants will receive structured training on the most critical aspects

of nuclear energy through a curriculum that blends academic rigour with practical industry experience.

Present at the launch of the Anugyan programme were Dr. V. K. Saraswat, former Member, NITI Aayog; Prof. B. S. Murty, Director, IIT Hyderabad; and Commodore R. D. Mane, President – Nuclear, CEEPL.

Prof. Murty said, “Nuclear energy will play an increasingly important role in India’s clean energy future as the country advances towards energy security and sustainable growth. This initiative reflects IIT Hyderabad’s commitment to creating industry-relevant learning opportunities that address national priorities and future technology needs.”

Commodore Mane said, “Our partnership with IIT Hyderabad represents a strong commitment to developing nuclear professionals of global standards through a curriculum delivered by leading academicians, scientists and industry experts.”

Dr. Saraswat stated that India’s ambitious target of achieving 100 GWe of nuclear power by 2047 would require the combined efforts of government, industry, academia and research institutions. He emphasised the need for advanced research, indigenous technology development and skilled manpower to support next-generation reactors, including Small Modular Reactors (SMRs). He welcomed the collaborative initiative involving IIT Hyderabad, IIT Jammu and Crimson Energy to support research, technology development and human resource creation, including the proposed experimental micro modular reactor programme.

The curriculum covers reactor physics, reactor engineering, radiation shielding, nuclear safety, thermal hydraulics, reactor instrumentation and control, waste management, quality assurance, emergency preparedness and advanced nuclear technologies such as SMRs. Participants will also have access to simulators and the Centre for Design Excellence supported by Dassault Systèmes. Upon successful completion, participants will receive a joint certification from IIT Hyderabad and Crimson Energy Experts.

The programme forms part of a broader initiative to build a structured talent pipeline aligned with India’s

nuclear ambitions by integrating classroom learning with insights from experienced Department of Atomic Energy professionals. It prepares participants for careers across the nuclear value chain, including nuclear power plants, SMRs, engineering design, advanced manufacturing, EPC projects, digital technologies, nuclear supply chains, safety compliance and regulatory affairs.

The programme is intended for early- and mid-career engineers, managers from EPC companies, manufacturing professionals, engineering consultants, power-sector personnel, executives from public sector undertakings and organisations seeking to diversify into the nuclear sector.

Upon successful completion, participants will:

- Develop a sound technical understanding of modern reactor systems and the operating principles of the nuclear industry.
- Engage confidently with technology vendors, OEMs and international partners.
- Evaluate nuclear project opportunities from both commercial and regulatory perspectives.
- Understand nuclear-specific supply chain management and large-scale EPC project execution.
- Navigate India’s nuclear regulatory framework and participate effectively in industry consultations and forums.

Limited to just 35 participants, Anugyan offers an immersive learning environment with close interaction with faculty and industry experts, making it one of India’s first programmes specifically designed to bridge the gap between academia and the rapidly expanding nuclear industry. ■

Windergy India 2026: Mapping the Next Phase of Wind Energy Scale



Windergy India 2026 - Where industry leaders connect, ideas evolve and partnerships take shape.



India's wind energy sector is comprehensively expanding, shifting the focus toward the robust value chain required to deliver scale, resilience, and long-term growth. Backed by progressive policy frameworks, breakthrough technologies, and an advanced domestic manufacturing base, the sector is now fully equipped to deliver on India's wind energy targets. Against this backdrop, Windergy India 2026 serves as a purpose-driven platform where the industry converges. Convening decision-makers, innovators, manufacturers, developers, investors, and policymakers under one roof, the platform serves as the intersection for the exchange of ideas, strategic partnerships, and cross-border expertise, driving this transformation.

Scheduled from **7-9 October 2026** at the **Chennai Trade Centre**, this 8th edition will spotlight advancements in turbine technology, component manufacturing, digitalisation, grid integration, energy storage, operations and maintenance (O&M), offshore wind, and emerging wind energy solutions.

Windergy India 2026 is supported by the Ministry of New and Renewable Energy (MNRE) and apex industry bodies, including the German Agency for International Cooperation (GIZ), German Wind Energy Association (BWE), German Offshore Wind Energy Foundation, Spanish Institute for Foreign Trade (ICEX), Danish Energy Export, India Energy Storage Alliance (IESA), National Institute of Wind Energy (NIWE), Indian Wind Power Association (IWPA), National Solar Energy Federation of India (NSEFI), Net-Zero Energy

Transition Association (NETRA), and Skill Council for Green Jobs (SCGJ). Anchoring this powerhouse ecosystem, leading OEMs such as Suzlon, Envision, Senvion, Adani, Venwind Reflex, Nordex, Sany, GE Vernova, and Vayona Energy will be present, alongside key component manufacturers including Winergy, ZF Wind, Bonfiglioli, Globe Ecologistics, Nexhs Renewable, Mobil, Nabros, and Sanghvi. Further elevating this global dimension, country pavilions from Denmark, Germany, and Spain will showcase their innovations, reinforcing Windergy India's role as a premier hub for international collaboration and industry advancement.

For exhibitors, Windergy India 2026 offers a targeted arena to showcase innovations, strengthen market presence, engage key buyers, and unlock commercial opportunities. Concurrently, trade visitors gain direct access to cutting-edge innovations, market intelligence, and policy perspectives shaping the direction of wind energy in India and globally.

This momentum is evident; with 90 per cent of the exhibition space already taken, the market has clearly signaled its priorities. The overwhelming early response reinforces Windergy India 2026 as the definitive annual gathering where the industry aligns to capture its next wave of growth. ■

Beyond Sourcing: Rethinking India's Gas Security in a Logistics-Constrained Market



Vijay Agrawal
Managing Director & Sector Lead
Infrastructure
Equirus Capital

*Crude oil diversification is enabled by system flexibility, not just strategy, emphasizes **Vijay Agrawal, MD & Sector Lead Infrastructure, Equirus Capital**. Through this article, he explains why Indian gas majors need to diversify their geo-political risks to ensure business continuity.*

India's success in diversifying crude oil sourcing is not merely a function of policy intent, but a direct outcome of the structural flexibility embedded in global crude markets and India's downstream configuration. Over the past decade, India has expanded its crude procurement across Russia, the Middle East, the United States, Africa and Latin America, with no single supplier exercising structural dominance over the basket. This diversification has been particularly evident post-2022, where discounted Russian barrels scaled rapidly to account for ~35–40 per cent of India's crude imports, displacing traditional Middle Eastern suppliers without requiring any fundamental reconfiguration of infrastructure.

This flexibility is underpinned by three technical factors.

First, crude oil is a fungible and specification-tolerant commodity. While crude grades differ in terms of API

gravity and sulphur content (light vs heavy, sweet vs sour), Indian refineries are largely configured with high Nelson Complexity Index (NCI) configurations (typically 9–12+), enabling them to process a wide range of crude slates. Complex refineries, operated by players such as Reliance Industries and Indian Oil Corporation, are equipped with secondary processing units such as cokers, hydrocrackers and desulphurisation units, allowing refiners to optimise crude intake based on price arbitrage rather than being locked into specific grades. This technical flexibility is a key enabler of sourcing diversification.

Second, crude oil benefits from a deep and liquid global shipping ecosystem. The global tanker fleet — comprising VLCCs, Suezmax and Aframax vessels — operates with significant depth and standardisation. Crude cargoes can be rerouted across geographies with minimal constraints, supported by established benchmarks such as Brent and

India's downstream and logistics infrastructure is structurally designed for high throughput and flexibility. The country has over 250 MMTPA of refining capacity, with coastal refineries capable of handling large crude carriers and integrated with extensive pipeline networks for evacuation and product distribution.

WTI, and a highly active spot and derivatives market. For India, this means that cargoes can be sourced opportunistically from any basin and delivered within predictable freight economics. Even long-haul crude imports from the US Gulf Coast or West Africa remain commercially viable due to scale efficiencies in large crude carriers and the absence of cargo-specific constraints.

Third, India's downstream and logistics infrastructure is structurally designed for high throughput and flexibility. The country has over 250 MMTPA of refining capacity, with coastal refineries capable of handling large crude carriers and integrated with extensive pipeline networks for evacuation and product distribution. Strategic Petroleum Reserves (SPR) — currently ~5.3 MMT with planned expansion — further enhance supply security by allowing crude inventory buffering independent of immediate refining requirements. In addition, refiners maintain commercial inventories and have the ability to dynamically adjust crude slates based on refinery margins (GRMs), further reinforcing procurement flexibility.

Taken together, these factors create a system where crude sourcing is primarily an economic optimisation problem rather than a logistical constraint. Indian refiners can pivot between suppliers based on relative pricing, geopolitical developments and refining economics without facing material infrastructure bottlenecks.

LNG Markets are Structurally Logistics-Constrained, Limiting True Diversification

Natural gas operates within a fundamentally different market architecture compared to crude oil, and this distinction is most visible once gas enters the LNG value chain. Unlike crude — where transport is largely commoditised — LNG supply chains are asset-linked and capacity-constrained at every stage, from liquefaction to shipping to regasification. Each cargo is effectively "pre-engineered" through a combination of upstream liquefaction trains, dedicated shipping schedules and terminal-specific regasification slots. This makes LNG far less fungible in practice, even if it is globally traded in theory.

From a transport standpoint, LNG introduces a set of constraints that do not exist in crude markets. Cargoes are carried in specialised cryogenic vessels with limited global fleet availability (~700–750 LNG carriers globally), and voyage economics are directly impacted by boil-off gas (typically ~0.1–0.15 per cent per day), which creates a hard trade-off between distance and delivered volume. Unlike crude tankers, LNG vessels are also tied to specific terminal compatibility (jetty design, regas capacity, berth availability), limiting the ability to dynamically reroute cargoes. As a result, LNG trade is less about 'where gas is available' and more about how efficiently it can be moved through a constrained logistics chain.

This has direct implications for India. With ~50 per cent of its gas demand met through LNG imports (~30–35 MTPA), the country is structurally dependent not just on supply availability, but on continuous functioning of a tightly coupled transport network.

Within this, concentration risks are significant. India's LNG imports (~55–60 per cent) originate from Qatar and the UAE, and ~65–70 per cent of total volumes

Financial Year	2011-12	2014-15	2017-18	2020-21	2021-22	2022-23	2023-24	2024-25
Net Production (MMSCM)	46,453	32,693	31,731	27,784	33,131	33,664	35,717	35,594
LNG import (MMSCM)	17,849	17,608	26,734	33,198	31,028	26,304	31,795	35,720
Total Consumption (MMSCM)	64,302	50,301	58,465	60,981	64,159	59,969	67,512	71,314
% of Import	27.8%	35.0%	45.7%	54.4%	48.4%	43.9%	47.1%	50.1%

transit through the Strait of Hormuz. This effectively means that a majority of India's gas supply is exposed to a single upstream region and a single maritime corridor simultaneously — a dual concentration that is far more acute than in crude markets.

Supplier	Share
Qatar	47.3%
UAE	13.5%
USA	10.5%
Oman	7.7%
Angola	7.3%
Others	7.2%
Nigeria	6.6%

Importantly, this concentration is not a strategic oversight — it is an outcome of transport economics. LNG supply from Qatar reaches India in ~4–5 days, compared to ~20–25 days from the US Gulf Coast. Given boil-off losses and vessel charter costs, this difference materially impacts landed pricing. Freight alone can add \$1–2/MMBtu for long-haul cargoes, while extended voyages increase working capital cycles and exposure to spot charter volatility. As a result, Middle Eastern LNG remains structurally cheaper, often by 25–35 per cent on a landed basis, making it difficult for Indian buyers to diversify away without eroding downstream affordability.

However, what appears as cost efficiency at the system level also embeds a transport fragility. LNG shipping markets are thin relative to crude, with vessel availability becoming a binding constraint during periods of disruption. Unlike crude, where alternative tankers can be sourced relatively easily, LNG carriers operate on tight scheduling cycles linked to liquefaction output. Any disruption — whether at the upstream (e.g., liquefaction outages) or midstream (e.g., chokepoint closures) — quickly cascades into physical cargo delays rather than just price adjustments.

Recent geopolitical events have highlighted this dynamic. Disruptions in the Middle East led to a sharp tightening in LNG vessel availability, with charter rates spiking above \$200,000/day and cargo movement delays across Asia. Simultaneously, concentration at the supply source — with Qatar's Ras Laffan complex accounting for ~20 per cent of global LNG supply — amplified the shock. The key insight here is that LNG markets adjust not just through price, but through physical dislocation of cargo flows, which directly impacts import-dependent systems like India.

India's Gas System Is Cost-Efficient but Structurally Fragile under Disruption

For India, this translates into a structurally asymmetric impact. In the absence of meaningful storage buffers, the system is forced to adjust on the demand side. One of the most defining characteristics of India's natural gas market — and a critical constraint to its expansion — is its high degree of price sensitivity, particularly in industrial and commercial segments. Unlike developed markets where gas demand is relatively inelastic, India operates as a fuel-switching economy, where gas competes directly with alternative fuels such as fuel oil, LPG, petcoke and coal. This has two important implications. First, gas demand in India is not structurally locked in; it is contingent on relative price competitiveness. Second, any volatility in LNG prices is quickly transmitted into demand destruction, particularly in non-priority sectors. This behaviour was clearly observed during the global gas price spike in 2022, where LNG prices crossed \$25–30/MMBtu, leading to a sharp decline in industrial gas consumption in India.

Segment	Share of Demand	Price Sensitivity	Ability to Switch	Allocation Priority
Fertilizer	~30%	Low	No	Highest
CGD (PNG + CNG)	~20–25%	Moderate	Limited	High
Power	~10–15%	Very High	Yes	Low
Industrial / C&I	~25–30%	Very High	High	Lowest

India's gas market is not homogeneous — it operates under a priority allocation framework, which further amplifies price sensitivity in certain segments.

This price-sensitive demand structure has direct implications for how India should approach LNG sourcing and energy security. **First**, cost competitiveness becomes non-negotiable. Any strategy that materially increases landed LNG prices — such as long-haul diversification — risks triggering demand destruction in industrial segments. For example Morbi cluster shifted to Propane due to price differentials from natural gas. This reinforces the structural importance of Middle Eastern supply, which remains the lowest-cost option.

Second, price volatility translates into volume volatility. Unlike crude oil, where demand remains relatively stable, LNG demand in India fluctuates based on price cycles. This creates challenges for importers such as GAIL

(India) Limited and Petronet LNG in managing long-term contracts versus spot exposure.

Third, supply disruptions have a disproportionate impact on industrial output. During periods of constrained LNG availability, gas is diverted toward priority sectors such as households and fertilizers, leaving industrial users exposed to both volume cuts and higher replacement fuel costs.

The critical takeaway is that India's vulnerability is not simply a function of supplier concentration, but of transport concentration and system inflexibility. Diversifying sourcing toward the US, Africa or Australia does not eliminate this risk — it merely shifts it. Longer supply chains increase dependence on LNG carrier availability, amplify freight volatility, and expose buyers to inter-basin arbitrage dynamics where cargoes are diverted to higher-priced markets. In effect, diversification in LNG is not equivalent to diversification in crude; it introduces a different set of risks anchored in logistics rather than geopolitics.

India has made progress in addressing some of these constraints. Regasification capacity has expanded to ~45–50 MTPA, with terminals across Dahej, Hazira, Kochi and Dhamra improving physical access points. The increasing use of FSRUs has reduced infrastructure lead times and added incremental flexibility at the margin. Market mechanisms such as the Indian Gas Exchange are also improving short-term balancing and price discovery, albeit from a low base.

Domestic production has seen modest recovery (~34–36 bcm), driven by KG Basin developments from Reliance Industries and Oil and Natural Gas Corporation, but remains insufficient to materially reduce import dependence. More importantly, these developments do not address the core issue of system-level buffering capacity. In its current form, India's gas ecosystem remains highly efficient under normal conditions, but fragile under stress. The next phase of evolution will therefore require a shift from sourcing optimisation to system resilience, with a sharper focus on transport flexibility, storage infrastructure and procurement design.

Building Gas Security Requires System Resilience, Not Just Supply Diversification

Building resilience in India's gas ecosystem requires a shift in approach — from securing molecules to securing the system that delivers those molecules. In LNG markets,

supply risk is not just upstream; it is embedded across the logistics chain. As a result, the solution set must be anchored in transport flexibility, buffering capacity and procurement optionality, rather than conventional sourcing diversification.

The most immediate structural gap in India's system is the absence of temporal flexibility — i.e., the ability to decouple consumption from real-time imports. Unlike crude oil, where strategic petroleum reserves and commercial inventories provide weeks of buffer, India's gas system operates with near "just-in-time" supply. This makes it acutely vulnerable to even short-duration disruptions in LNG flows.

Introducing strategic gas storage — even at a modest scale of ~2–3 bcm, equivalent to ~15–20 days of LNG imports — would fundamentally alter system behaviour. It would convert supply shocks from physical shortages into inventory drawdowns, allowing the system to absorb disruptions without immediate demand curtailment. In effect, storage is not just a buffer; it is a mechanism to reduce the elasticity of demand to logistics disruptions.

Parallel to storage, the second lever lies in reconfiguring procurement from point-source dependency to portfolio access. Traditional LNG contracting structures tie buyers to specific liquefaction assets, implicitly exposing them to both upstream and transport risks associated with that geography. In contrast, global portfolio players such as Shell plc, TotalEnergies and BP operate aggregated supply books across basins and optimise cargo delivery dynamically. The key insight here is that these players are not just suppliers — they are logistics optimisers. By internalising vessel scheduling, route optimisation and cargo diversion, they effectively transform fixed supply chains into flexible ones. For Indian buyers, greater reliance on such portfolios shifts the problem from managing physical constraints to managing contractual optionality.

A third, often underappreciated, dimension of resilience is control over shipping capacity. LNG markets differ from crude in that vessel availability itself can become a binding constraint during disruptions. The global LNG carrier fleet is relatively concentrated and operates on tight utilisation cycles, meaning that in periods of stress, access to ships — not just gas — determines supply continuity. For India, which is structurally long LNG imports, this creates an asymmetry: upstream contracts may exist, but without shipping access, they cannot be executed. Developing strategic exposure to LNG carriers

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through long-term charters or equity participation can therefore provide logistics sovereignty at the margin. This is particularly relevant in scenarios where freight markets dislocate and spot vessel availability collapses.

A review of global LNG-importing markets highlights a consistent pattern — resilience is not achieved by eliminating dependence, but by engineering flexibility into the system. Countries such as Japan and South Korea, despite being almost entirely import-dependent, have effectively de-risked their gas supply through large storage buffers, portfolio-based procurement and control over logistics chains.

Europe, similarly, has responded to supply shocks by mandating storage levels and deepening market liquidity, ensuring that disruptions translate into price signals rather than physical shortages. In contrast, India's gas ecosystem remains optimised for cost efficiency under normal conditions, with limited redundancy in storage or transport. This creates an asymmetric risk profile, where supply shocks are absorbed not through inventory or rerouting, but through demand curtailment in price-sensitive sectors. The key insight, therefore, is that India does not face a supply problem in isolation — it faces a system design problem, where the absence of buffers and flexibility amplifies the impact of otherwise manageable disruptions.

Beyond these core levers, incremental improvements in domestic production and infrastructure flexibility play a complementary role. Additional volumes from basins such as KG-D6 (operated by Reliance Industries and Oil and Natural Gas Corporation) provide marginal relief by reducing import intensity at the system level. Similarly, FSRUs and expanded regasification capacity introduce spatial flexibility, enabling cargo intake across multiple entry points. However, these measures do not eliminate dependence; they merely reduce system rigidity at the edges.

The broader insight is that India's gas ecosystem today is optimised for cost efficiency under normal conditions, but not for resilience under stress. The crude oil playbook — centred on supplier diversification — does not translate effectively because LNG risk is not solely upstream; it is embedded in the midstream logistics architecture. Middle Eastern LNG will continue to dominate India's supply mix due to its structural freight advantage, and any attempt to displace it materially would raise system-wide costs.

Conclusion

The strategic question, therefore, is not how to diversify away from this dependence, but how to de-risk it without compromising economics. This requires a layered approach: introducing storage to absorb shocks, leveraging portfolio suppliers to create routing flexibility, and securing shipping access to ensure cargo mobility.

In short run, India can source gas from spot market to meet domestic demand and without locking itself in costly long term contracts. This will help in meeting short term demand without disrupting Industrial productions.

As India's gas demand scales toward ~70–80 bcm over the next decade, these transport-led considerations will become increasingly central to energy security. In LNG markets, reliability is not defined by access to supply alone, but by the ability to move that supply through a constrained and interdependent system.

The strategic priority, therefore, is not to diversify away from cost-efficient Middle Eastern supply, but to de-risk it through system design — by building strategic storage buffers, securing flexible portfolio access, and developing control over LNG logistics. In doing so, India can transition from a price-taker exposed to disruptions to a system that is structurally resilient, without compromising affordability. ■

From Efficiency to Resilience: How the Strait of Hormuz Crisis is Rewriting Energy Logistics



Pushpank Kaushik
CEO & Head of Business Development
(Subcontinent,
Middle East, and Southeast Asia)
Jassper Shipping

*The ongoing crisis in the Strait of Hormuz demonstrates the fragility of global supply chains that are overly reliant on a limited number of shipping routes. The existing situation is not simply a temporary adjustment, but rather an indication of an overall paradigm shift in how logistics is being approached, emphasizes **Pushpank Kaushik, CEO & Head of Business Development (Subcontinent, Middle East, and Southeast Asia), Jassper Shipping.***

For many years, the Strait of Hormuz has been a potentially vulnerable choke point in international trade, particularly for energy. A significant share of the world's crude oil and LNG transits through this narrow waterway from the Persian Gulf to the world markets. According to the U.S. Energy Information Administration report, around 21 million barrels per day, roughly 20 per cent of global petroleum consumption, passes through the Strait of Hormuz, making it a significant route for trade.

Disruption to this area does not remain regional and usually has an immediate impact on shipping schedules, freight rates and fuel prices on a global marketplace, indirectly impacting the taxes and rise in cost of usual

products. Even when routes remain technically open, the risk perception alone is enough to slow down decision-making across the logistics chain.

Current Challenges and Strategic Pathways in Energy Logistics

The situation has exposed clear gaps in energy logistics, with delays and cautious vessel movement becoming common. For countries like India, this is directly increasing import costs and affecting the wider supply chain.

From Cost Efficiency to Risk Management: A key challenge is that traditional cost-focused planning is no longer sufficient in an uncertain environment. Disruptions

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around critical routes like the Strait of Hormuz make low-cost options unreliable. The pathway forward is shifting towards risk-based planning, adding buffer timelines, opting for more stable routes even at higher costs, and making contracts flexible to absorb fluctuations in freight and insurance. The emphasis is now placed on delivering a continuous supply, where efficiency and assurance of the future supply chain are balanced with resilience.

Route Diversification and Alternative Corridors: Diversifying routes is critical due to limited infrastructure and the scale at which energy logistics operates. Not all alternative corridors can handle large volumes efficiently. The practical approach is partial diversification, using safer transit lanes, rerouting where possible, and leveraging regional hubs and limited multimodal options to reduce dependency on high-risk routes. In some cases, selecting longer transport routes or modifying shipment schedules in order to avoid high-risk areas and sudden disruption.

Role of Technology and Real-Time Decision Making: Another hurdle is the lack of real-time visibility during disruptions, which delays response and decision-making. The solution lies in better use of technology, real-time tracking to monitor vessel movement, predictive tools to flag risks like congestion, and scenario planning to prepare alternate routes in advance. This improves visibility and enables quicker, more informed decisions during uncertain situations. Scenario planning is becoming more prevalent as companies look for alternative routes during planning. It has a major impact on enhanced visibility; when companies are up-to-date on the proper information at the appropriate time, the speed of decision-making and practical results are improved, even in the case of disruption.

Future Implications for Global Energy Supply Chains

If such disruptions continue, the impact will extend beyond short-term adjustments and start influencing how energy supply chains are planned. It is gradually encouraging countries and companies to build more resilience into their systems, such as increasing storage capacity to reduce dependence on just-in-time deliveries, which are more vulnerable in uncertain conditions.

There is also a growing push towards diversifying sourcing regions and reducing reliance on a few critical routes. This is likely to guide future investments in ports, pipelines, and alternative logistics corridors. Overall, the direction is not just about managing disruption, but about creating more balanced systems where resilience is planned alongside cost and efficiency.

Building Resilient Energy Logistics Systems

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Increasingly, the emphasis is shifting towards developing supply chain systems that can tolerate shocks through increased diversification, improved planning, and enhanced utilisation of technology. While efficiency will continue to be significant, it will no longer be the sole driving force in future supply chain systems.

In the long run, the companies and countries that adapt to this balance between efficiency and resilience are likely to be better positioned to handle any kind of future disruptions. ■

High-Performance Chemistries for Electrical Insulation & Electronic Protection Applications: Growth Opportunities



Anurag Roy
Managing Director
ELANTAS Beck India Ltd

*One of the most interesting shifts happening across industries today is that performance expectations are rising faster than the technologies themselves. Whether it is renewable energy, electric mobility, data centres, industrial automation, or advanced consumer electronics, the conversation is often centered around capacity expansion, digitalisation, electrification, and efficiency. Yet beneath these visible developments lies a less discussed reality: the materials enabling these systems are being asked to deliver far more than they did a decade ago, emphasizes **Anurag Roy, Managing Director, ELANTAS Beck India Ltd.***

Electrical insulation and electronic protection materials were traditionally expected to provide safety, reliability, and operational continuity. Today, they are expected to manage heat more effectively, support higher power densities, withstand increasingly demanding operating conditions, contribute to sustainability goals, and enable longer equipment life. As industries evolve, the role of these materials is evolving with them.

Shift Driven by Emerging and Established Sectors

India's renewable energy ambitions continue to accelerate, supported by large-scale investments in solar, wind, and energy storage infrastructure. The country's target of achieving 500 GW of non-fossil fuel capacity by 2030 is

driving significant activity across generation, transmission, storage, and grid modernisation. At the same time, electric mobility continues to gain momentum, creating demand for increasingly sophisticated motors, power electronics, charging systems, and battery technologies. Alongside these developments, another major growth driver is emerging in the form of digital infrastructure. The rapid expansion of artificial intelligence, cloud computing, and data-intensive applications is fuelling unprecedented investment in data centres globally and in India. These facilities operate with extremely low tolerance for downtime, making reliability, thermal management, and electrical protection critical considerations throughout the system architecture.

Even traditional sectors such as transportation, industrial equipment, consumer electronics, and power distribution

are experiencing steady growth while simultaneously becoming more technologically advanced. In many cases, products are becoming compact, lighter, more powerful, and more connected than before.

As a result, the challenges that insulation and protection materials must solve have become significantly more complex. Consider electric mobility as an example. Modern EV motors operate at higher power densities within increasingly compact spaces. Higher operating temperatures, thermal cycling, inverter-driven systems, vibration, and exposure to demanding environmental conditions create performance requirements that traditional insulation systems were not originally designed to address. A similar trend can be observed across power electronics. As electronic systems become smaller and more powerful, thermal management has become one of the most critical engineering challenges. Components are expected to dissipate heat quickly while maintaining electrical insulation, protecting sensitive electronics, and ensuring long-term reliability.

The same principle applies to data centres. As computing density increases and systems operate continuously, even minor failures can have significant operational consequences. Reliability is no longer simply a maintenance consideration. It has become a business imperative. These evolving expectations are reshaping the innovation focus for the industry.

Innovation for Higher Performance

Customers increasingly require materials capable of operating under higher temperatures, higher voltages, and more demanding service conditions. Longer equipment lifecycles, reduced maintenance requirements, and higher system availability have become standard expectations across industries. In many applications today, reliability directly influences efficiency, productivity, operating costs, and overall business performance.

Innovation through Application-Specific Solutions

No two industries face identical challenges. The requirements of an EV motor differ significantly from those of a solar inverter, a battery energy storage system, an industrial transformer, or a data centre power supply. As applications become more specialised, customers are

seeking solutions tailored to their specific operational requirements rather than generic approaches. This is driving closer collaboration between material manufacturers, equipment manufacturers, and OEMs. Increasingly, innovation is becoming a process of co-creation rather than product development in isolation.

Innovation for Sustainability and Resource Efficiency

Historically, discussions around insulation materials focused primarily on electrical and mechanical performance. Today, sustainability considerations are becoming equally important. Across global markets, there is growing interest in materials that reduce emissions, improve resource efficiency, support recyclability, and lower environmental impact throughout their lifecycle. Customers are increasingly evaluating not only how a material performs during operation but also how it contributes to broader sustainability objectives. This trend is encouraging the development of lower-emission formulations, resource-efficient manufacturing processes, and technologies that reduce energy consumption during application and processing. For India, these developments represent a significant opportunity.

The country's growth across renewable energy, electrification, energy storage, electronics manufacturing, and digital infrastructure is creating sustained demand for advanced insulation and protection materials. At the same time, there is increasing emphasis on localisation and strengthening domestic manufacturing capabilities. Many advanced chemistries and specialised materials continue to be imported. However, growing customer demand, supportive policy initiatives, and the broader manufacturing ecosystem are creating favourable conditions for greater domestic capability development.

The opportunity extends beyond manufacturing capacity alone. It requires continued investment in research development, application engineering, testing infrastructure, technical talent, and supply chain resilience. Building indigenous capabilities in high-performance insulation and electronic protection materials will be critical to supporting the next phase of India's industrial growth. More importantly, it will position India not only as a manufacturing destination but also as a contributor to global innovation in advanced materials. ■

Floating Solar: Expanding the Boundaries of Solar Deployment



Parveen Jangra
Founder, CTO & COO
TrueRE Oriana Power

*As the global energy transition scales, the question is no longer just about adding renewable capacity, it is about where and how to deploy it. In many markets, land, once considered abundant for solar expansion, is fast becoming a structural constraint. Not because solar demand is slowing, but because suitable, contiguous land parcels are becoming harder to secure, more expensive, and slower to aggregate. This is where floating solar, in my view, changes the equation, writes **Parveen Jangra, Founder, CTO & COO, TrueRE Oriana Power.***

It is important to clarify upfront that floating solar is not in competition with land-based solar. Ground-mounted systems will continue to anchor the bulk of renewable capacity globally.

Floating Solar

Floating solar plays a different, and increasingly critical role, in that it unlocks locations where land is either unavailable, commercially unviable, or operationally complex. In that sense it is a strategic extension of solar deployment.

What makes this particularly compelling is that we are not creating new infrastructure ecosystems, but rather, optimising existing ones. Water bodies such as reservoirs, irrigation ponds, and industrial basins already exist within the energy and public utility landscape. Using these surfaces for power generation allows us to expand capacity without triggering the same level of land-use conflict.

In India alone, the estimated floating solar potential exceeds 200 GWp across feasible water bodies, positioning it as one of the most significant untapped segments within the renewable energy landscape.



TrueRE's floating solar project, Kutch, Gujarat

From a technology standpoint, floating solar has matured faster than many expected. Early concerns around durability and performance have largely been addressed through advancements in float design, anchoring systems, and corrosion-resistant materials, making floating solar a technically robust solution rather than an experimental one.

Operational Advantages

There are also inherent operational advantages. The cooling effect of water improves module efficiency, leading to higher generation compared to equivalent ground-mounted systems. Over the life of a project, even modest efficiency gains translate into meaningful improvements in yield and project economics.

Challenges

One of the persistent challenges in scaling renewables in India has been land acquisition. Fragmented ownership, regulatory complexity, and cost escalation often introduce delays and uncertainty. Floating solar bypasses many of these issues. Water bodies, typically controlled by government or public sector entities allow for more structured access and clearer development

pathways. This not only reduces execution risk but also improves project predictability, an increasingly important factor for investors and utilities alike.



From a technology standpoint, floating solar has matured faster than many expected. Early concerns around durability and performance have largely been addressed through advancements in float design, anchoring systems, and corrosion-resistant materials, making floating solar a technically robust solution rather than an experimental one. In India alone, the estimated floating solar potential exceeds 200 GWp across feasible water bodies, positioning it as one of the most significant untapped segments within the renewable energy landscape.



Encouragingly, cost competitiveness, which was also once a concern, is evolving in the right direction. While early projects carried a premium over ground-



TrueRE's floating solar project, Udaipur, Rajasthan

mounted systems, the gap has been steadily narrowing due to scale, standardisation, and technological advancements. In several recent tenders, floating solar bids have approached parity with conventional solar, reinforcing its commercial viability.

Growing Potential

Where I see an even stronger and more immediate commercial case is in island and land-scarce economies. In many of these markets, power generation still relies heavily on imported diesel. This creates structurally high electricity costs, driven not just by fuel prices but by logistics, storage, and supply chain vulnerabilities. When your baseline cost of power is already elevated, the economics of renewables shift dramatically.

In such contexts, floating solar is not just viable, it is often the most financially sensible option from day one. Water bodies such as lagoons and reservoirs provide natural deployment sites, while the avoidance of fuel imports directly improves energy security and price stability.

There is also a strategic overlay here. For island economies that depend on tourism and global investment, sustainability is no longer optional. Visible,

large-scale renewable infrastructure, like floating solar, signals a clear commitment to clean energy, which increasingly influences both investor sentiment and visitor preferences.

Looking ahead, the next frontier for the sector lies in marine or offshore floating solar. The potential is vast, particularly for densely populated coastal regions, but so are the engineering challenges. Saltwater corrosion, wave dynamics, and anchoring complexities require a different level of design sophistication.

That said, progress is tangible. Advances in high-density polyethylene floats, improved coatings, and hybrid mooring systems are steadily building confidence in the segment. As these technologies mature, offshore floating solar could open up entirely new geographies for solar deployment.

Our Journey

Reflecting on our own journey, the evolution of this segment has been particularly instructive. When we first entered the floating solar space, industry confidence in executing these projects at scale was still limited. There were valid questions around design reliability, long-term



TrueRE's floating solar project, Visakhapatnam, Andhra Pradesh

performance, and bankability. For us, the decision to invest early was a deliberate one. We saw floating solar not as a niche experiment, but as a necessary capability for the future of solar deployment.

That early commitment meant building expertise from the ground up, across engineering, procurement, and on-ground execution, at a time when the ecosystem itself was still evolving. Today, as the segment gains wider acceptance, that early groundwork is beginning to translate into tangible scale.

Our recent 234 MW project with Damodar Valley Corporation is a case in point. Beyond its size, what is significant is what it represents; growing institutional confidence that floating solar can deliver reliably at utility scale. These kinds of projects are important not just for individual developers, but for the credibility of the sector as a whole.

Future Outlook

I believe floating solar will play a defining role in the next phase of renewable energy growth, not because it replaces existing solutions, but because it expands the canvas on which we can build. As land availability becomes more constrained and the demand for clean

energy continues to accelerate, the ability to deploy solar intelligently across diverse environments will become a key differentiator.

Floating solar gives us that flexibility. And increasingly, that is what the energy transition will demand. ■

Made in India, Powering the World: Toshiba's T&D Achievements in 2025



Hiroshi Furuta

Chairman & Managing Director
Toshiba Transmission & Distribution Systems (India)
Pvt Ltd

*As we move forward into 2026, we are taking a moment to look back at 2025 — a year of progress for Toshiba's Transmission & Distribution (T&D) business in India. This is a recap of our key milestones and indigenous achievements from the past year, along with a glimpse of what lies ahead. From expanding our manufacturing footprint to delivering India's first Mobile Gas-Insulated Switchgear (m-GIS) solution, here is how we worked to strengthen the country's power infrastructure and support its Make-in-India vision, writes **Hiroshi Furuta, Chairman & Managing Director, Toshiba Transmission & Distribution Systems (India) Pvt Ltd.***

Through Toshiba Transmission & Distribution Systems (India) (TTDI), we made a significant commitment to India's energy sector with an investment of ₹562 crore (JPY 10 billion) to expand our Rudraram facility in Telangana. This expansion was formalized through a Memorandum of Understanding (MoU) with the Government of Telangana, reinforcing our partnership with the state to advance industrial growth and energy security.

Key highlights of Investment

- Establishing a CRGO Core Processing Centre with an annual capacity of 12,000 Metric Tonnes (MT), successfully inaugurated in August 2025.

- Launching a dedicated Surge Arrester Production Line, designed to manufacture 80,000 units per year, ensuring enhanced grid protection and reliability.
- Increasing our power transformer production capacity from 30,000 MVA to 42,000 MVA annually, strengthening India's transmission infrastructure for the future.

Scaling for Global Demand

Together with India, Toshiba is preparing for the future of global electricity demand. In October 2025, we announced an additional JPY 35 billion investment in TTDI and our Hamakawasaki Operations in Japan. This

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The plan includes modernizing production lines, upgrading infrastructure, and expanding product portfolios to serve diverse markets — from India to North America, Europe, and the Middle East. These efforts reinforce TTDI's role as Toshiba's global hub for T&D equipment and our commitment to support the transition to a more sustainable energy future.

Innovation: Born in India

Year 2025 was also a year of technological breakthroughs driven by collaboration and local ingenuity. In close partnership with Power Grid Corporation of India (POWERGRID), TTDI delivered the country's first indigenous 220kV m-GIS — a solution designed and manufactured in India, for India.

This achievement reflects more than technical progress; it showcases how India-led innovation can address the nation's unique grid challenges. The m-GIS system enables rapid deployment, disaster recovery, and flexible grid operations, ensuring resilience for a power network that serves diverse and evolving needs.

After the October announcement, TTDI successfully delivered another indigenous 132kV m-GIS solution to POWERGRID in November. We will continue this journey of co-innovation with POWERGRID by delivering India's first 400kV m-GIS system by August 2026. These advancements reaffirm our commitment to engineering solutions tailored for India while meeting global standards of reliability and efficiency.

Global Reach & Future Outlook

Today, TTDI exports India-made transformers to more than 50 countries, reinforcing India's position as a trusted global manufacturing base for high-voltage T&D equipment. This achievement has been recognized by EEPC India's National Export Awards. Having previously received the Star Performer Award five times, TTDI reached a new milestone in 2025 by winning the Outstanding Export Performance award. This accomplishment stands as a testament to TTDI's role in strengthening India's capability to manufacture and export complex, high-value engineering products to both developed and emerging markets — contributing to the nation's economic growth, technological leadership, and green energy transition.

As we move forward, we will continue to innovate for India's grid, expand our global reach, and deepen partnerships that support sustainable growth. Key priorities include:

- Delivering India's first 400kV m-GIS system by August 2026.
- Expanding production capacity for transformer, switchgears, and surge arresters to meet rising domestic and global demand.
- Enhancing localisation of advanced technologies to support India's renewable energy integration.

India is central to Toshiba's transmission and distribution strategy. Through sustained investments and strong partnerships, we are committed to building a competitive manufacturing base that supports India's energy goals and global market demand. TTDI will continue to champion the 'Make in India' vision by producing locally, innovating for India, and expanding exports worldwide. ■

Development in Steel Grades for Transportation of Oil & Gas through Steel Pipelines



Rajiv Thakur
President – Corporate Affairs
Fortran Steel Pvt Ltd

*Pipeline steel evolution has moved from basic carbon steels (X42–X52) → high-strength TMCP steels (X60–X70) → ultra-high strength and hydrogen-ready steels (X80–X120 and beyond). The focus today is not just strength, but a balanced combination of fracture toughness, weldability, corrosion resistance, and future fuel compatibility. **Rajiv Thakur, President – Corporate Affairs, Fortran Steel Pvt Ltd**, explains in detail how steep grades have developed and where the technology stands today.*

The development of steel grades for oil and gas pipelines has been one of the most important enablers of modern energy infrastructure. Over the last few decades, pipeline steels have evolved significantly in terms of strength, toughness, weldability,



corrosion resistance, and suitability for extreme environments such as deepwater, arctic regions, and sour (H₂S-rich) service.

Below is a structured overview of how steel grades have developed and where the technology stands today.

1. Evolution of Pipeline Steel Grades (API 5L Standard)

Most oil and gas pipelines used steels conforming to the API 5L Pipeline Steel Standard.

Early generations (1950s–1980s) of API Steel Grade are as follows:

- **Steel Grades:** API X42, X46, X52
- **Key focus:** Steel strength and weldability

GUEST COLUMN

- **Manufacturing Process:** Mostly normalized or controlled rolled steel
- **Limitations:**
 - o Lower oil and gas pipe pressure capacity
 - o Lower fracture toughness
 - o Not suitable for harsh environments like sour gas or undersea pipelines

Year 1980 to 2000s Medium Strength Steels (1980s-2000s) Limited to Strength of Maximum 65 kg/cm².

- **Grades** were API X60 & X65
- **Improvements brought about from 80s were :**
 - o Thermo-Mechanical Controlled Processing (TMCP) mostly in case of hot rolled steel coils
 - o Improved toughness at low temperatures like -20°C
 - o Marked improvement on weldability of pipes



The major shift was on the ability to build cross country high-pressure pipelines.

Modern high-performance grades (2000s-present)

- **Grades:** X70, X80
- **Key characteristics:**
 - o High strength with controlled carbon equivalent
 - o Excellent fracture toughness (CTOD resistance)
 - o Better resistance to fatigue and seismic loads
- **Used in:**
 - o Cross-country trunk pipelines
 - o High-pressure transmission lines



Ultra-high strength grades (Emerging/Limited Use & Still under trial run)

- **Grades:** X90, X100, X120
- **Status:** selective deployment and ongoing qualification
- **Challenges:**
 - o Weldability control
 - o Hydrogen-induced cracking resistance
 - o Field repair complexity
- **Applications:**
 - o High-capacity transmission corridors
 - o Next-gen hydrogen-ready pipelines still in the lab stage



2. Key Breakthroughs - Technology, Environment-Specific Specialization, Emerging Hydrogen Transport Transition etc.

Technological Advancement - Key Metallurgical Developments

To reach higher performance metrics without making the steel brittle, the industry shifted from traditional casting to highly advanced metallurgical processing (Refer Table 1).

(a) Thermo-Mechanical Controlled Processing (TMCP)

- Controlled rolling + accelerated cooling
- Produces fine-grain bainitic/martensitic structures
- Enables high strength without excessive carbon

(b) Microalloying technology

Common elements:

- Niobium (Nb)
- Vanadium (V)
- Titanium (Ti)
- Boron



Benefits:

- Grain refinement
- Precipitation strengthening
- Improved toughness-to-strength balance
- Reduced crack initiation sites

(c) Clean Steel Metallurgy

Modern pipeline steels require:

- Ultra-low sulphur and phosphorus
- Inclusion free shape controlled (calcium treatment)
- Vacuum degassing



This has resulted in substantial improvement on resistance to fracture.

(d) Sour Service Steel Development

For H₂S-rich oil and gas:

- Resistance to SSC (Sulfide Stress Cracking)
- Low hardness microstructure
- Compliance with NACE MR0175 / ISO 15156



(e) Corrosion-resistant and coated pipeline steels

Advancements include:

- CRA (Corrosion Resistant Alloy) clad pipes
- Internal epoxy / FBE coatings
- External 3LPE / 3LPP coatings



Environment-Specific Specialization

Modern steel pipeline grades are heavily tailored to combat specific degradation mechanisms encountered in complex terrains:

1. Sour Service (H₂S Environments)

When transporting oil and gas containing Hydrogen Sulfide (H₂S), moisture triggers Hydrogen-

Feature / Technique	Traditional Process	Modern Developed Process	Target Benefit
Microalloying	Standard Carbon-Manganese (C-Mn) chemistry.	Precise additions of Niobium (Nb), Vanadium (V), Chromium (Cr), and Titanium (Ti).	Fine grain refinement and precipitation hardening.
Microstructure	Ferrite and pearlite bands.	Acicular ferrite or dual-phase structures.	High deformability, crack arrest, and high yield strength.
Rolling Tech	Conventional thick slab processes.	TMCP and Accelerated Cooling (AccC) or Thin Slab Casting (TSCR).	Avoids centreline segregation; enhances low-temperature toughness.

Table 1

Induced Cracking (HIC). To combat this, steel manufacturers utilize deep refining techniques outside the furnace to guarantee ultra-low sulfur and phosphorus levels. A specialized Calcium-Silicon (Ca-Si) treatment is applied to change the morphology of remaining inclusions, rendering them spherical and harmless to prevent crack propagation.

2. Cold Region Applications

Pipelines running through polar or sub-zero climates require extreme low-temperature fracture toughness to prevent catastrophic brittle failure. Steel plants subject these pipes to V-notch Charpy impact tests and Drop Weight Tear Tests (DWTT) to ensure the metal retains high energy absorption capabilities at sub-zero temperatures.

3. Deepwater & Offshore Applications

Offshore line pipes must withstand both high internal pressures and immense external hydrostatic water pressure. Development here has moved toward heavy-wall, high-collapse-strength X65 to X70 and X80 pipes (with wall thicknesses up to 34 mm). They feature highly precise pipe geometry to resist crushing, combined with advanced anti-corrosion coatings like fusion-bonded epoxy.

4. Strain-Based Designs (Seismic Areas)

In areas prone to landslides, earthquakes, or permafrost thawing, standard pipelines buckle due to ground movement. Metallurgists have created dual-phase high-deformability steel grades (X65 to X100). These pipes yield smoothly over a wide range of strain without snapping, allowing the line to bend safely with moving soil.

5. Emerging Horizon: Hydrogen Transport Transition

With the energy transition accelerating, pipeline steel research is intensely focused on hydrogen compatibility. High-yield transmission steels are highly vulnerable to hydrogen embrittlement. Current metallurgical initiatives by major producers like ArcelorMittal focus on refining continuous casting to eliminate centreline segregation, ensuring low residual alloy levels, and validating existing line pipe networks for safe blended hydrogen delivery.

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3. Modern Design Requirements for Pipeline Steels

Today's pipeline steels must satisfy multiple simultaneous constraints:

Mechanical requirements

- High yield strength (up to 120 ksi class)
- High fracture toughness at -40°C or lower
- High strain capacity (for seismic zones)

Operational requirements

- High internal pressure (up to 250 bar in some cases)
- Resistance to cyclic loading
- Compatibility with intelligent pigging systems

Environmental requirements

- Arctic / deepwater conditions
- CO₂ / H₂S transport
- Hydrogen blending readiness (future transition)



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4. Current Industry Trends

(a) Hydrogen-ready pipeline steels

One of the fastest-growing R&D areas:

- Resistance to hydrogen embrittlement
- Special microstructures to prevent crack propagation
- Compatibility with green hydrogen networks

(b) High-Strain Line Pipe (HSLP)

- Designed for geologically active zones
- Allows controlled deformation instead of brittle fracture

(c) Digital metallurgy & simulation

- AI-based alloy design
- Finite element modelling of pipeline fracture behavior
- Digital twins for pipeline integrity

5. Key Global Steel Producers in Pipeline Grades

Major producers developing advanced pipeline steels:

- ArcelorMittal / AMNS India – X70 to X100 grades, global pipeline supply
- Tata Steel – API X70/X80 grades, strong presence in India & Europe
- Nippon Steel
- POSCO & Vallourec, France (Seamless Line Pipe Specialization)

Future Outlook

The next decade will likely see:

- Wider adoption of X80–X100 grades
- Commercialization of hydrogen transmission pipelines
- Shift toward low-carbon steel production routes (EAF + DRI) - Green Steel
- Increased use of clad and composite pipeline systems
- Higher integration of real-time monitoring sensors in pipes

(This is the first article of a 3-series on steel pipes used for transportation of oil and gas.) ■

Rajiv Thakur is a Metallurgy & Steel Industry Expert. He can be contacted at -

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Suraj Limited: Dedicated towards Technical Excellence & Quality Products



Suraj Limited, is an ISO-9001:2015, 14001:2015, OHS AS 45001:2018 certified company, PED approved and Government Recognized Export House and one of the world's leading producers and exporters of stainless steel, alloy steel, carbon steel seamless pipes, tubes, fittings and flanges. With over three decades of expertise, we serve critical industries including Oil & Gas, Petrochemicals, Power, Nuclear, Defense, Fertilizers, and Water Treatment across 60+ countries.

Manufacturing Infrastructure

Suraj Limited operates from two state-of-the-art plants in Gujarat, India:

- **Thol Plant:** Dedicated to seamless pipes, tubes, and fittings with hot extrusion, cold pilgering, and finishing facilities.
- **Chandarda Plant:** Specialized in carbon and alloy steel forged fittings and flanges with advanced forging, heat treatment, and machining lines.

Our total installed capacity exceeds 24,000 MT per annum.

Quality Assurance

We have our own in-house testing laboratory with modern testing equipment to carry out all mandatory as well as optional tests on the products. Complex tests for which we do not have in-house facilities will be conducted at an external third party approved test house. Products will also be supplied under third party inspection where customer demands.

Certifications & Approvals

- Our manufacturing is PED 2014/68/EU approved, and we hold product approvals from IBR, EIL, ONGC, BHEL, NTPC, and major global EPCs.
- We are also approved by international inspection agencies like Bureau Veritas, DNV, TUV, Lloyd's, and SGS.

Commitment

At Suraj Limited, we believe every customer has unique needs. Our technical and commercial teams work closely with clients to offer customized solutions, reliable delivery, and dedicated after-sales support.

Key Highlights

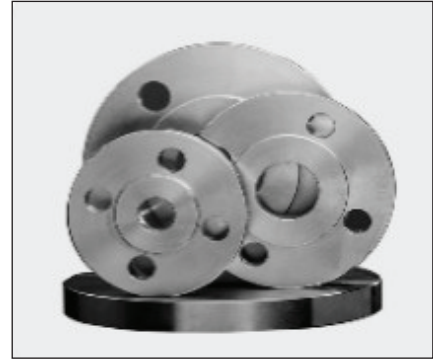
- Gujarat-based Suraj Limited is one of the world's leading producers and exporters of stainless steel, alloy steel, carbon steel seamless pipes, tubes, fittings and flanges.
- SO-9001:2015, 14001:2015, OHS AS 45001:2018 certified company.
- PED approved and Government Recognized Export House.
- Operates from two state-of-the-art plants in Gujarat.
- Company's total installed capacity exceeds 24,000 MT per annum.



Seamless Hot Finish Mother Pipe



Stainless Steel Seamless Heat Exchanger U-Tubes



Stainless Steel Flanges



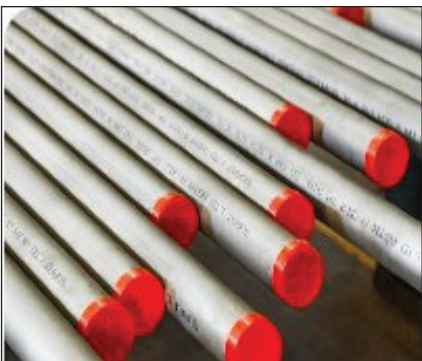
Stainless Steel Seamless Butt weld Fittings



Stainless Steel Seamless Heat Exchanger Tubes



Stainless Steel Forged Rings



Stainless Steel Seamless Pipes

- **Heat Exchanger 'U' Tubes:**
12.70 mm to 50.80 mm OD
- **Hydraulic & Fuel Injection Tube:**
6.00 mm to 114.00 mm OD

Grades: AISI-304, 304L, 304H, 304N, 304LN, 309, 310, 310S, 316, 316L, 316H, 316Ti, 316N, 317, 317L, 321, 347, 405, 410

Duplex: UNS-S32750, S32760, S31803, S31500, S32205, S32304 and Its Equivalents in DIN, NFA, JIS, etc.

Length: Pipes up to 11.800 meter long and tubes up to 20 meter long ■

For detailed product information, please visit :
www.surajgroup.com

Product Range

- **Stainless Steel Seamless Pipes:**
1/8 NPS to 6 NPS
- **Stainless Steel Seamless Butt-weld Pipe Fittings:** 1/2 NPS to 12 NPS
- **Stainless Steel Seamless Stubends (Type A):**
1/2 NPS to 12 NPS
- **Stainless Steel Flanges:** 1/2 NPS to 40 NPS
- **Stainless Steel Forged Rings:**
Max. 1200 mm OD
- **Heat Exchanger Tubes:**
6.00 mm to 101.60 mm OD

STFI Advocates Policy Justice for Solar Thermal in National Programmes



Jaideep N. Malaviya

Founder and Secretary General
Solar Thermal Federation of India (STFI)

*With his extensive experience in solar energy market research for European publications, Jaideep N. Malaviya, Founder and Secretary General, Solar Thermal Federation of India (STFI), was invited by European experts to act as a catalyst between industry and government in advancing initiatives under the United Nations Development Programme. In an exclusive interview with **Oil Gas & Power**, Mr. Malaviya recounts his journey of championing solar thermal energy in India's energy landscape — a path that ultimately led to the establishment of STFI, the country's pioneering national body for solar thermal, and only the second of its kind globally after Europe.*

Jaideep N. Malaviya, Founder and Secretary General, of the Solar Thermal Federation of India (STFI) begins with his inspiration and vision to establish the Solar Thermal Federation of India (STFI), he reflects, "The objective was to accelerate the adoption of solar thermal technologies to decarbonize heating. Although my primary focus had been on solar photovoltaics (PV), I accepted the challenge. As I was consistently compiling data on solar installations, I convened a meeting of all solar water heater manufacturers. They welcomed the idea of creating a pan-India body and entrusted me with the responsibility of leading it. This culminated in the formation of the Solar Thermal Federation of India (STFI) — the second national solar thermal body in the world, after Europe."

Highlighting the opportunities and challenges in advancing solar thermal adoption in India, Mr. Malaviya explains, "India's renewable energy journey began with solar thermal technologies such as cookers and water heaters in the 1990s, which quickly gained popularity due to the energy demand they addressed. To encourage adoption, the government introduced subsidies that attracted consumers. When the National Solar Mission was launched in 2010, it included a target of 20 million m² of solar thermal installations,

supported by generous subsidies. Coupled with the UNDP programme offering nominal fiscal incentives, the solar thermal market witnessed a boom post-2010, achieving nearly 18 million m² by 2015."

He further adds, "However, limited funding made it difficult to sustain the subsidy burden against the growing applications. By the end of 2014, the UNDP programme also concluded. With no subsequent initiatives to promote solar thermal, the market entered a decline as the national focus shifted entirely towards solar photovoltaics (PV)."

Decarbonizing heating is pivotal, and STFI is at the forefront of addressing industry challenges while championing solar thermal alongside photovoltaics. Highlighting STFI's evolving role in India's renewable energy transition, He notes, "To curb cheaper imports and uphold quality, STFI has been instrumental in establishing standards through the Bureau of Indian Standards (BIS). Today, STFI stands as the national voice for solar thermal, with a long-term roadmap to expand its penetration. Solar thermal offers nearly three times the conversion efficiency of PV for low-temperature heating needs. The potential is immense — with over 250 million m² identified for solar water heaters, the technology can significantly aid demand-



Solar Water Heater

side management by reducing peak loads on electric utilities. Karnataka provides a compelling example, where mandatory solar water heaters in residential buildings have ensured uninterrupted electricity supply without load-shedding."

Recommending policies to accelerate solar thermal adoption in India, Mr. Malviya observes, "It is unfortunate that solar thermal has been overlooked in the government's current market acceleration programme for solar energy. Since it is also a rooftop technology, STFI has strongly urged that it be included under the *Pradhan Mantri Surya Ghar Yojna*, which presently covers only solar PV. Solar thermal is a low-cost solution, affordable to the common man, delivering reliable hot water with minimal maintenance."

He adds, "STFI has successfully persuaded the Ministry of New and Renewable Energy (MNRE) to initiate a subsidy programme in the North-East, Himalayan regions, and island territories, where electricity costs are high due to transmission and distribution losses. The identified potential exceeds 300,000 m², which could annually offset around 300 million kWh of fossil-fuel electricity and cut the carbon footprint by 250,000 tons."

Further underscoring the key innovations in solar thermal heating and storage, he explains, "Solar water heating systems have advanced significantly with innovations such as high-efficiency coatings, glass-lined inner storage tanks to address water hardness, and hybrid technologies that integrate heat pumps to deliver sustainable hot water around the clock. The

Bureau of Indian Standards (BIS) has already specified standards for hot water storage tanks, and a dedicated task force has been established to drive continuous improvements."

Sharing his perspective on integrating solar thermal into India's industrial decarbonization roadmap, he explains, "STFI undertook a three-year study titled 'Solarpayback', funded by the German government, to assess the potential of industrial heating up to 150°C. The study identified promising segments such as dairy, food processing, breweries, textiles, chemicals, and rubber processing, while also evaluating solar thermal systems installed under UN programmes. The findings revealed that India's average Direct Normal Irradiation (DNI) and limited land availability make payback periods long. Unless highly efficient concentrating systems with precise solar tracking are developed, industrial solar thermal heating will remain challenging. However, solar thermal concentrating cooking for community needs shows strong promise, provided regular maintenance is ensured."

Reflecting on India's global standing in the solar thermal market, Mr. Malviya concludes, "Until the subsidy programme was withdrawn in 2014, India ranked among the top five solar thermal countries globally. It continues to hold a position within the top ten markets. With the right policies, India has the potential to rebound into the top three, given the vast demand for hot water across its large population." ■

Goldi Solar: Powering India's Green Revolution!



Capt. Ishver Dholakiya
Founder & Managing Director
Goldi Solar Pvt. Ltd

Established in 2011 by Capt. Ishver Dholakiya, Founder & Managing Director, Goldi Solar Pvt. Ltd has grown into India's largest solar PV (photovoltaic) module manufacturer, achieving a record-breaking expansion to 15.2 GW capacity within just 14 months. Capt. Dholakiya reflects on his remarkable journey and the milestones that shaped Goldi Solar's leadership in the clean energy sector.

Goldi Solar's growth has been anchored in a single conviction — India's clean energy future must rest on robust domestic manufacturing. Beginning in Surat in 2011–12 with a modest 10 MW solar PV module facility, the Goldi Solar has transformed into a 15.2 GW integrated solar powerhouse with a footprint spanning five continents. Today, the company stands at the forefront of renewable energy innovation and sustainability, globally recognized for its high-efficiency modules, AI-powered facilities, and unwavering commitment to India's net-zero vision.

Initial Journey

Throwing light on the initial journey and breakthroughs Capt. Dholakia tells, "A defining milestone came with Goldi Solar's rapid scale-up from 3 GW to 15.2 GW in just 14 months, marking one of the fastest capacity expansions in India's renewable energy sector. Along this journey, Goldi Solar broadened its manufacturing base, diversified into EPC services, adopted AI-driven production systems, and is now venturing into solar cell manufacturing. This evolution not only underscores Goldi Solar's remarkable trajectory, but also mirrors India's rise as a global leader in renewable energy."

Challenges

Talking about the challenges in the renewal energy sector faced then Capt. Dholakiya says, "The real challenge in the early years was to build conviction around a sector that was still at a very nascent

stage. When started exploring renewable energy after the 2008 recession, solar was still viewed with uncertainty, banks were hesitant to finance it, and the ecosystem in India was only beginning to take shape. So, the first task was to help people see that green energy was not a short-term opportunity but a long-term national necessity. We had to convince our own teams, financial institutions and other stakeholders that India's future growth would depend on cleaner domestic energy, reduced dependence on crude oil imports, and stronger energy independence. That required patience, repeated conversations and the willingness to stay invested in the sector even before it had mainstream acceptance."

Innovation

Throwing light on the technological innovation achieved in Heloc® Plus series Mono-facial and bifacial modules, he tells, "The HELOC® Plus series has been built to deliver higher generation, stronger reliability and better long-term project economics. In the bifacial TOPCon range, the focus is on improving module conversion efficiency of up to 23.01 per cent, while enabling 10-30 per cent additional power generation through rear-side gain compared with regular modules. It also addresses key field-performance concerns through better weak illumination response, low LID and LeTID with N-type solar cell technology, and strong anti-PID performance to limit degradation. What makes the series stand out is the balance of



high output, lower LCOE, reduced BOS cost and wider applicability across BIPV, vertical installations, snowy regions, and high-humidity, windy or dusty environments, supported by 12 years warranty for materials and processing and 30 years warranty for linear power output."

He further adds, "Goldi Solar is approaching AI, IoT and robotic cleaning as part of the shift towards smarter solar manufacturing and operations. Our scale-up from 3 GW to 15.2 GW in just 14 months has been supported by India's first AI-powered solar PV module manufacturing capabilities, with AI and AOI enabling greater precision, consistency and process control. Next-generation stringer technology further strengthens output quality at scale. On the field side, our modules are designed to support digital monitoring, IoT-led performance tracking and automated O&M practices, including robotic cleaning, making them suitable for more data-driven solar assets."

Expertise

Goldi Solar's expertise lies in module manufacturing having incorporated innovations in inverter technology to improve efficiency. Cap. Dholakia, tells, "We see the future of solar as an integrated ecosystem. Inverters are becoming smarter—with better power conversion, real-time monitoring, grid support and storage compatibility. Our focus is to ensure that our high-efficiency modules work seamlessly with these technologies, maximizing energy generation and long-term system performance."

Future Plans

Talking about initiatives to expand solar adoption in rural India, he further tells, "Rural India represents one of the biggest opportunities for solar adoption, particularly

across rooftops, agriculture and decentralized energy. For us, the priority is to make solar more visible, trusted and practical for communities beyond large utility-scale projects. A strong example of this is our work in completely solarising Chikhaldha and Dudhala, which reflects how clean energy can directly support rural households and local communities. Alongside such initiatives, our nationwide channel partner, distributor and EPC network helps us reach customers across smaller towns and rural markets making it easier for developers and customers to access funding and adopt solar with greater confidence."

While, the Government policies have created a strong foundation for India's solar manufacturing ecosystem. Initiatives such as PM Surya Ghar are accelerating rooftop solar adoption, while PM-KUSUM is helping take solar deeper into rural and agricultural use cases. At the manufacturing level, government frameworks on local manufacturing are pushing the industry towards stronger quality standards, backward integration and reliable Indian supply chains. Captain Dholakia adds, "For Goldi Solar, this aligns with the larger vision of *Aatmanirbhar Bharat* and *Viksit Bharat*, where India does not only consume clean energy, but builds the manufacturing strength to lead the energy transition."

India will achieve its clean energy ambitions through a strong, self-reliant manufacturing ecosystem, and Goldi Solar is committed to playing its part in building that future. As the country works towards 500 GW of non-fossil fuel capacity by 2030, the need for reliable, high-quality, made-in-India solar manufacturing has never been greater. Captain Dholakia concludes by saying, "We're investing in advanced manufacturing, AI-powered production, high-efficiency technologies and solar cell manufacturing to strengthen the domestic solar value chain." ■

Roofsol Energy: Driving India's Clean Energy Transformation through Scalable Solar Innovation



Dipankar Pal

Managing Director
Roofsol Energy Pvt Ltd

Roofsol Energy Pvt. Ltd. is one of India's leading onsite solar company and renewable energy solution providers, delivering innovative, scalable, and future-ready solar infrastructure for businesses and communities across the country. With more than a decade of industry expertise, Roofsol has emerged as a trusted clean energy partner for leading industrial and commercial organizations seeking sustainable and cost-efficient energy solutions.

Today, Roofsol stands among India's most recognized rooftop solar companies with over 400 MW+ installed capacity, 250+ projects executed across India, and a growing network of 200+ corporate clients spanning industries such as automotive, FMCG, pharmaceuticals, textiles, plastics, warehousing, engineering, infrastructure, and consumer goods.

The company's growth has been driven by a strong focus on engineering depth, execution reliability, and customer-centric energy solutions. Rather than offering standardized systems, Roofsol designs solar solutions tailored to each client's energy profile, operational requirements, and long-term performance goals. This approach has enabled the company to build long-standing relationships with some of India's leading manufacturing and industrial brands.

Roofsol has consistently demonstrated its ability to execute complex projects across multiple geographies while maintaining high standards of quality, safety, and operational excellence. Through robust engineering practices, experienced execution teams, strong vendor partnerships, and standardized project management systems, the company delivers projects efficiently while ensuring long-term plant reliability and performance.

One of Roofsol's landmark achievements includes the successful execution of one of the world's largest single-location rooftop solar projects — a 26 MWp rooftop solar installation in Punjab, India — showcasing the company's capability to deliver utility-scale rooftop projects with precision and engineering excellence.

The company operates across CAPEX, OPEX/RESCO, and Open Access models, enabling customers to choose energy solutions aligned with their financial and operational strategies. Roofsol has witnessed significant growth in the OPEX/RESCO segment, reflecting the increasing demand for long-term



Roofsol Energy Project: Shriram Pistons & Rings Pvt. Ltd, Pathredi, Rajasthan, 1.9 MWp



Roofsol Energy Project: Greenlam Industries Ltd, Naidupeta, Andhra Pradesh, 4MWp

Power Purchase Agreement (PPA) models within the Commercial & Industrial (C&I) sector. The company has already signed PPAs aggregating approximately 120 MWp, with over 50 MWp commissioned, and continues to expand its clean energy asset portfolio across India.

Roofsol's strong market position has also been recognized by industry-leading research organizations. CRISIL-Bridge to India ranked Roofsol among India's top rooftop solar companies, recognizing the company as India's No. 1 Rooftop Solar Project Developer and No. 2 Rooftop Solar EPC Contractor, a reflection of its execution capabilities, project scale, and customer trust.

In addition to its industrial and commercial leadership, the company has expanded into the residential rooftop solar market through Roofsol Homes, its dedicated B2C business vertical focused on delivering customized solar solutions for homes and housing societies. Roofsol Homes combines the engineering strength of Roofsol Energy with a customer-centric approach, helping residential consumers adopt solar energy through transparent communication, seamless execution, and long-term service support.

Recognizing the evolving energy landscape and the growing importance of energy storage in renewable energy deployment, Roofsol Energy is strategically expanding its focus into Battery Energy Storage Systems (BESS). With several state governments introducing energy storage mandates alongside solar installations and strong policy support from the Government of India to accelerate grid stability and renewable integration, BESS is emerging as a critical component of future

energy infrastructure.

Leveraging its extensive portfolio of over 200+ corporate clients and deep expertise in solar project execution, Roofsol is well-positioned to offer integrated Solar + BESS solutions that enhance energy reliability, optimize power consumption, and maximize renewable energy utilization. The company views energy storage as a natural extension of its clean energy offerings and a significant growth opportunity in India's rapidly expanding renewable energy sector.

Under the leadership of Mr. Dipankar Pal, Roofsol Energy continues to focus on building future ready energy infrastructure that supports India's industrial growth while accelerating decarbonization efforts. According to Mr. Pal, rooftop solar is rapidly evolving from a cost-saving solution into a strategic energy asset that enhances energy security, operational sustainability, and long-term business competitiveness. He strongly believes that India's renewable energy transition will be driven by innovation, scalable OPEX models, technology-led asset management, and growing consumer awareness across both industrial and residential segments.

As solar technologies continue to evolve, Roofsol remains committed to adopting high-performance and bankable technologies that deliver measurable value, reliability, and operational efficiency for customers. The company continues to strengthen its O&M capabilities through real-time monitoring, preventive maintenance, and performance optimization strategies to ensure long-term energy generation and asset performance.

With a strong pan-India presence, advanced engineering expertise, and a long-term vision for sustainable growth, Roofsol Energy Pvt. Ltd. continues to empower industries and communities with clean, reliable, and economically viable solar energy solutions — contributing meaningfully toward India's renewable energy and decarbonization goals. ■

For more details:

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Website: www.roofsol.com

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'Websol' Committed to Supporting India's Clean Energy Ambitions!



*Websol Energy System Ltd is a leading photovoltaic manufacturer, producing advanced solar cells and modules designed for utility-scale, commercial, and industrial projects across India and global markets. **Sohan Lal Agarwal, Executive Director and Managing Director of Websol Energy System Ltd**, in an exclusive interview with **Oil, Gas & Power** magazine, throws light on the company's growth trajectory focussing on India's emerging opportunities and the pressing challenges within the global renewable and solar energy sector.*

Sohan Lal Agarwal

Executive Director & Managing Director
Websol Energy System Limited

How would you describe the growth journey of Websol since inception?

Websol's journey has been one of resilience, innovation, and continuous evolution. With over 36 years of experience in the solar industry, we have witnessed and contributed to the transformation of solar energy from a niche technology to a mainstream power source. Since our inception, we have focused on building strong manufacturing capabilities, adopting advanced technologies, and maintaining stringent quality standards.

How would you describe the growth of the solar industry over the past 10 years?

The growth of the solar industry over the past decade has been extraordinary. India's installed solar capacity has increased from a few gigawatts to becoming one of the largest solar markets globally. Strong policy support, declining technology costs, increased awareness about sustainability, and growing energy demand have all contributed to this expansion. The sector has also witnessed significant advancements in manufacturing technologies, module efficiencies, project execution capabilities, and financing mechanisms. Today, solar energy is among the most competitive sources of electricity generation, making it a key pillar of India's energy transition strategy.

Do you feel solar energy is the best form of renewable energy which India can tap to achieve energy transition goals?

India possesses one of the world's highest solar irradiation levels, making solar energy a natural choice for large-scale renewable energy deployment. While every renewable source has its role, solar offers unmatched scalability, flexibility, and cost competitiveness. Solar can be deployed across utility-scale projects, rooftop installations, agricultural applications, industrial facilities, and remote regions. When combined with energy storage solutions and a modernised grid, solar energy can significantly contribute to India's de-carbonisation goals, energy security, and sustainable economic growth.

What according to you are the major challenges in the growth of the solar energy manufacturing industry?

The industry has made significant progress, but several challenges remain. These include dependence on imported raw materials, rapid technological changes requiring continuous investment, access to affordable financing, and maintaining competitiveness in a highly dynamic global market. Another critical challenge is the development of a robust domestic supply chain across the entire solar value chain. Investments in research

and development, skilled manpower, infrastructure, and advanced manufacturing technologies will be essential to building long-term competitiveness and reducing external dependencies.

If you compare the global solar manufacturing industry versus India, where does India stand?

India has made remarkable progress and is emerging as a significant player in the global solar manufacturing landscape. The country has substantially expanded its manufacturing capacity in recent years, supported by proactive government initiatives and increasing domestic demand.

While countries such as China continue to dominate the global supply chain due to scale and ecosystem maturity, India is steadily strengthening its position. With continued investments in technology, vertical integration, innovation, and manufacturing infrastructure, India has the potential to become a major global hub for solar manufacturing in the coming years.

What are the criteria for ensuring growth in the solar manufacturing industry?

Sustainable growth requires a combination of policy stability, technological innovation, infrastructure development, and a strong domestic supply chain. Manufacturers must continuously invest in advanced technologies to improve efficiency, quality, and cost competitiveness.

Equally important are investments in research and development, workforce training, quality assurance systems, and environmental sustainability. Collaboration between industry stakeholders, policymakers, research institutions, and financial institutions will be crucial for creating a globally competitive manufacturing ecosystem.

How would you describe the growth of floating solar in India?

Floating solar is emerging as an important segment within India's renewable energy sector. It offers a practical solution for land-constrained regions by utilising existing water bodies such as reservoirs, lakes, and industrial ponds. Apart from generating clean energy, floating solar systems can reduce water

evaporation and improve land-use efficiency. Several large-scale projects have already demonstrated the viability of this technology. As India continues to diversify its renewable energy portfolio, floating solar is expected to witness substantial growth and become an increasingly important contributor to the country's clean energy mix.

What are the future plans of Websol?

Websol is focused on strengthening its position as a leading Indian solar manufacturer through capacity expansion, technology upgrades, and operational excellence. Our objective is to enhance our manufacturing capabilities in high-efficiency solar cells and modules while maintaining the highest standards of quality and reliability.

We also aim to deepen our engagement with domestic and international markets, strengthen our contribution to India's renewable energy ecosystem, and continue investing in innovation-driven growth. Sustainability, technological advancement, and customer trust will remain at the core of our future strategy.

How would you describe the future of the solar manufacturing industry?

The future of the solar manufacturing industry is extremely promising. Global commitments towards decarbonisation, increasing electricity demand, and growing adoption of clean energy technologies are creating unprecedented opportunities for the sector.

In India, supportive government policies, expanding renewable energy targets, rising investments, and increasing localisation efforts are expected to accelerate manufacturing growth. The industry is likely to witness continued advancements in cell efficiencies, manufacturing automation, energy storage integration, and smart energy solutions. As the world moves towards a low-carbon future, solar manufacturing will play a critical role in enabling energy security, economic development, and environmental sustainability. Companies that focus on innovation, quality, scale, and operational efficiency will be well-positioned to lead this transformation. ■

South Gujarat Shines Bright as India's Leading Sustainability-led Energy Hub!



Mr. Hiren Dhameliya

President, South Gujarat Solar Association (SGSA)

*South Gujarat has witnessed remarkable strides in renewable energy adoption over the last decade. **Mr. Hiren Dhameliya, President, South Gujarat Solar Association (SGSA), Surat**, throws light on South Gujarat emerging as a renewal energy state, driven by commitment to sustainability, in an exclusive interview with **Oil Gas & Power**.*

Please throw light on the initiatives towards the renewable energy sector evolved in your region (South Gujarat) over the past decade?

The South Gujarat region has transformed from being an emerging solar market into one of Gujarat's leading renewable energy clusters, having witnessed a remarkable growth in renewable energy adoption. This growth has been driven by progressive Government policies, increasing awareness among industries, declining solar tariffs, and the commitment of businesses towards sustainability.

The rapid implementation of rooftop solar, captive Open Access projects, agricultural solar pumps, and commercial & industrial (C&I) solar installations has significantly contributed to this transformation. Industrial hubs such as Surat, Bharuch, Ankleshwar, Vapi, Navsari and surrounding districts have increasingly adopted renewable energy to reduce energy costs and meet their Environmental, Social and Governance (ESG) commitments. Today, South Gujarat stands as a strong example of how industrial growth and clean energy can progress together.

What makes South Gujarat an attractive region for solar and renewable energy investments?

South Gujarat region has a strong industrial ecosystem comprising textile, diamond, chemical, pharmaceutical, engineering and manufacturing sectors, all of which have substantial electricity demand. This naturally creates a large market for renewable energy. Gujarat's proactive policies, excellent transmission infrastructure, ease of doing business, availability of skilled EPC companies, financial institutions, and experienced project developers further strengthen the investment ecosystem. Additionally, the entrepreneurial culture of South Gujarat enables industries to adopt new technologies quickly. Investors find confidence in the region due to stable industrial growth, supportive regulatory mechanisms and high payment discipline among industrial consumers.

What are the key challenges solar developers and EPC companies face in the region today?

While the sector has achieved significant growth, several challenges continue to impact project execution. The foremost challenge today is the availability and

timely procurement of ALMM-compliant solar modules and domestically manufactured solar cells. Policy transitions, though essential for strengthening domestic manufacturing, should also ensure uninterrupted project execution.

Developers also face challenges relating to land acquisition, transmission connectivity, evacuation infrastructure, financing costs, approval timelines and policy interpretation across various agencies. The Open Access segment has tremendous growth potential; however, maintaining policy stability and ensuring timely approvals are critical to sustain investor confidence. The industry believes that India can simultaneously strengthen domestic manufacturing while maintaining the momentum of solar deployment through practical and phased policy implementation.

How do you see the role of rooftop solar versus utility-scale solar projects evolving in Gujarat?

Both segments are equally important and complement each other. Utility-scale projects will continue to play a significant role in achieving India's ambitious renewable energy targets by supplying large quantities of green power to distribution companies and industries through Open Access. At the same time, rooftop solar is becoming an integral part of decentralized energy generation. Commercial establishments, residential consumers and MSMEs are increasingly adopting rooftop systems to reduce electricity costs and improve energy security. Future growth will not be a competition between rooftop and utility-scale solar; rather, both segments will work together to build a resilient, decentralized and sustainable energy ecosystem.

What sectors in South Gujarat have shown the strongest adoption of renewable energy solutions?

South Gujarat's textile industry has been one of the largest adopters of solar energy, followed by the diamond processing sector, chemical and petrochemical industries, pharmaceuticals, engineering units, food processing industries and educational institutions. Large industrial consumers are increasingly adopting captive and Open Access solar projects to achieve long-term energy cost savings while meeting their sustainability commitments. MSMEs have also emerged

as a significant growth driver. As financing becomes more accessible and awareness increases, renewable energy adoption among smaller industries continues to accelerate.

What is the role of South Gujarat Association in the renewable energy and solar sector in Surat region?

South Gujarat Solar Association (SGSA) serves as a bridge between the renewable energy industry and policymakers. Our mission is to promote sustainable growth of the solar ecosystem by representing the collective interests of developers, EPC companies, manufacturers, consultants and consumers. SGSA regularly engages with Central and State Government authorities, DISCOMs, regulatory bodies and financial institutions to provide constructive policy suggestions and resolve industry challenges.

"South Gujarat's textile industry has been one of the largest adopters of solar energy, followed by the diamond processing sector, chemical and petrochemical industries, pharmaceuticals, engineering units, food processing industries and educational institutions. Large industrial consumers are increasingly adopting captive and Open Access solar projects to achieve long-term energy cost savings while meeting their sustainability commitments."

The Association also organizes technical seminars, awareness programmes, training sessions and industry interactions to enhance knowledge sharing and encourage the adoption of best practices. At SGSA, we firmly believe that India's energy transition should be driven by a balanced approach that promotes domestic manufacturing, while ensuring uninterrupted deployment of renewable energy projects. ■

Premium Transmission's Journey from Local Roots to Global Reach



Neeraj Bisaria
Managing Director & President
Premium Group

*Founded in 1961, Premium Transmission's growth journey over the six decades, began as a power transmission business, eventually evolving into the Premium Group, a diversified industrial solutions organization serving both established industries and emerging sunrise sectors. **Mr. Neeraj Bisaria, MD & President Group, Premium Transmission** throws light on the company's journey from being an early adopter of geared motor technology in India through a technology acquisition from Germany to reinforcing its commitment to innovation and technological advancement.*

What have been the key milestones for Premium Transmission that have shaped the company's growth journey so far?

A key milestone has been the continuous strengthening of our core mechanical power transmission business through Premium Transmission. By expanding our portfolio of gearboxes, geared motors, fluid couplings, and drive solutions. While investing in advanced manufacturing and engineering capabilities, we have built a strong position across critical sectors including energy, infrastructure, mining, material handling, steel, cement, and other process industries. We established Premium Care in 2019 and introduced our Multi-Brand Care Centres (MCCs) in India and overseas, creating an organized lifecycle services platform focused on refurbishment, asset reliability, predictive maintenance, and asset management solutions. It created an organized platform for aftermarket services, multi-brand refurbishment of mechanical power transmission products, condition monitoring,

predictive maintenance, digital asset management, and reliability solutions, helping customers maximize uptime, improve reliability, and enhance operational efficiency.

In 2021, we expanded into the sunrise sectors through Premium Motion, reflecting our long-term commitment to supporting the energy transition. Through integrated solar tracking solutions and the acquisition of waterless solar cleaning robot technology, we have built capabilities that strengthen our presence within the renewable energy ecosystem and position us for future growth. Viewed collectively, these milestones represent a deliberate transformation from a power transmission company to a diversified industrial solutions group.

Today, the combined strengths of Premium Transmission, Premium Care, and Premium Motion enable us to support industrial growth, sustainability, and asset lifecycle management while creating long-term value for our customers and stakeholders.



What were some of the toughest hurdles the company faced, and how did your team overcome them?

One of the key challenges throughout our journey has been managing technological transitions while balancing the evolving expectations of both domestic and global customers. As industries advanced, customers increasingly sought higher efficiency, improved performance, and more sophisticated solutions. While global markets were generally quicker to adopt newer technologies, the challenge was to drive innovation without disrupting long-standing customer relationships.

Through close customer engagement, application engineering, and a strong focus on demonstrating lifecycle value, we were able to build confidence in new technologies and support a gradual transition. At the same time, we continued to invest in engineering capabilities, manufacturing technologies, and product development to ensure our solutions remained aligned with global standards. Looking back, this balanced approach enabled us to preserve customer trust, while driving technological advancement an approach that continues to define Premium's growth journey.

How has Premium Transmission stayed relevant in an industry that is witnessing rapid technological and market shifts?

A key strength of Premium has always been our engineering capability. While we offer a strong portfolio of gearboxes, geared motors, fluid couplings, and motion control products, our ability to develop customized technological solutions for complex applications continues to differentiate us in the market. We have also invested significantly in advanced manufacturing technologies, automation, and precision engineering to enhance quality, productivity, and responsiveness. Combined with our network of over 100 channel partners and Premium Care, the advanced multi brand care centres (MCC) across India and key global markets, this enables us to stay close to customers and respond quickly to their evolving needs.

Through AI-driven processes and our Asset Management System, we are helping customers improve asset reliability, optimize maintenance, and make better operational decisions through real-time data and insights. At the same time, through Premium Care and Premium Motion, we are able to address lifecycle management requirements and opportunities arising from the global transition towards renewable

energy.

How do you see renewal energy influencing the future of power transmission solutions?

The rapid expansion of renewable energy is one of the most significant shifts shaping the industrial landscape today. For India, this transition is particularly important as the country continues to invest heavily in solar, wind, green hydrogen, and sustainable infrastructure while strengthening its position as a global manufacturing hub. This shift is redefining expectations from power transmission solutions, as the customers are looking for solutions with higher energy efficiency, improved asset performance, greater reliability, and lower lifecycle costs. Premium Transmission is also expanding our presence in the renewable energy ecosystem through Premium Motion, with integrated solar tracking solutions and related technologies, which help improve energy generation and operational efficiency.

What opportunities do you see for Premium Transmission in supporting India's clean energy and renewable energy ambition?

The global energy sector is undergoing a structural shift towards renewable sources, driven by sustainability commitments, energy security priorities, and the improving economics of clean technologies. In India, this transition is gaining strong momentum, with solar emerging as the key driver, supported by the country's target of around 500 GW of non-fossil fuel capacity by 2030, along with large-scale investments in wind, green hydrogen, and related infrastructure.

Premium Transmission continues to serve a wide range of industries with customized and reliable power transmission solutions, we also see strong potential in the renewable energy ecosystem. Premium Motion, offerings include solar trackers, slew drives, control systems, and waterless solar cleaning robot technology, designed to enhance energy generation efficiency, operational reliability, and sustainability of solar assets.

We believe India's clean energy transition will continue to accelerate, and companies that combine engineering excellence with technology, reliability,

“Our goal is to create sustainable long-term value while strengthening our position across both traditional industries and emerging sunrise sectors. Ultimately, our aspiration is clear: to build globally recognized businesses across Premium Transmission, Premium Motion, and Premium Care, creating enduring value for customers, stakeholders, and the industries we serve.”

and lifecycle thinking, will play a key role in enabling this transformation. With our strong engineering foundation and focused presence in sunrise sectors, we are well-positioned to contribute meaningfully to this evolving energy landscape.

What steps is Premium Transmission taking to support the net-zero goals?

We are also increasing our reliance on renewable energy across our facilities. Our rooftop solar installations are being progressively expanded, and at our Shendra plant, it meets around 30 percent of the facility's electricity requirement, reducing dependence on conventional energy sources. In addition, we are focused on resource optimization across water, fuel, and utilities through targeted engineering interventions, helping us improve operational efficiency and reduce overall consumption. On the environmental front, we have implemented emission control measures that have helped significantly reduce particulate matter and gaseous emissions, with reductions of 70–90 percent in PM, NO₂, and CO levels, along with broader improvements in environmental performance.

What role do innovation and R&D play in developing energy-efficient and environmentally responsible solutions for your customers?

Our R&D approach is deeply customer centric enabling us to develop solutions tailored to their specific needs. This design-to-application approach improves performance alignment, reduces rework and rejection, and minimizes the consumption of raw materials and energy during manufacturing. Over the years, Premium Transmission has evolved from conventional

worm gearboxes to providing more advanced and energy-efficient solutions such as helical and planetary gear systems, designed for higher power density, improved efficiency, and enhanced performance. Our advanced fluid coupling solutions enable optimal sizing of the prime mover for specific applications, preventing oversizing and overdesign. This improves energy efficiency, reduces resource consumption, and supports more sustainable system design.

We have established a dedicated New Product Development Centre in Kolkata. The centre focuses on studying emerging technologies, evolving industry trends, and future customer requirements, enabling us to develop solutions aligned with the needs of the next five years and beyond. Our focus is on leveraging advanced technologies such as AI, machine learning, automation, and digital engineering to create smarter, more efficient, and sustainable solutions for our customers.

What are the most significant trends that will redefine the power transmission and industrial manufacturing landscape over the next five years?

Looking ahead, we believe AI and Machine Learning will significantly transform the industrial landscape over the next five years. These technologies have the potential to streamline the entire value chain from design and engineering to manufacturing and final product delivery driving higher productivity, improved accuracy, and faster execution. More importantly, AI-enabled processes will help organizations become increasingly system-driven rather than individual-dependent. This will enhance consistency, strengthen quality outcomes, accelerate decision-making, and reduce development and delivery timelines. We see this as a key enabler in building the next generation of efficient, reliable, and sustainable industrial solutions.

What message would you give for adopting greener and more sustainable business practices?

Sustainability is no longer just an environmental responsibility and should not be viewed merely as a compliance requirement; it is a business imperative. With governments across the world, including India,

introducing policies and frameworks that promote energy efficiency, lower emissions, and responsible resource utilization, the transition towards sustainable business practices is becoming increasingly important.

At the same time, creating a sustainable future requires collective action. Manufacturers, suppliers, customers, technology providers, and policymakers must work together to accelerate the adoption of cleaner and more efficient solutions. As industry leaders, we have a responsibility to balance growth with environmental stewardship. The organizations that successfully integrate sustainability into their strategy today will be better positioned to create long-term value and remain competitive in the future.

Where do you envision Premium Transmission in the next decade?

Our priorities are centred on strengthening our leadership in mechanical power transmission, while building high-growth businesses aligned with future industry trends. In Premium Transmission, we will continue to focus on expanding our market presence, enhancing our product portfolio, and delivering application-specific solutions that improve performance, reliability, and energy efficiency for customers across industries. A key growth driver for the future will be Premium Motion. Our ambition is to establish Premium Motion as a globally recognized brand and a leading player in its chosen markets through innovative solar tracking solutions and related technologies that enhance energy generation and operational efficiency.

At the same time, through Premium Care, our vision is to establish a strong network of advanced Multi-Brand Care Centres (MCCs) across strategic markets globally, ensuring access to world-class multi brand refurbishment, maintenance, and reliability services closer to their operations to support global customers. With faster response times and localized expertise, we intend to position Premium Care as one of the leading lifecycle services brands in the mechanical power transmission industry. ■

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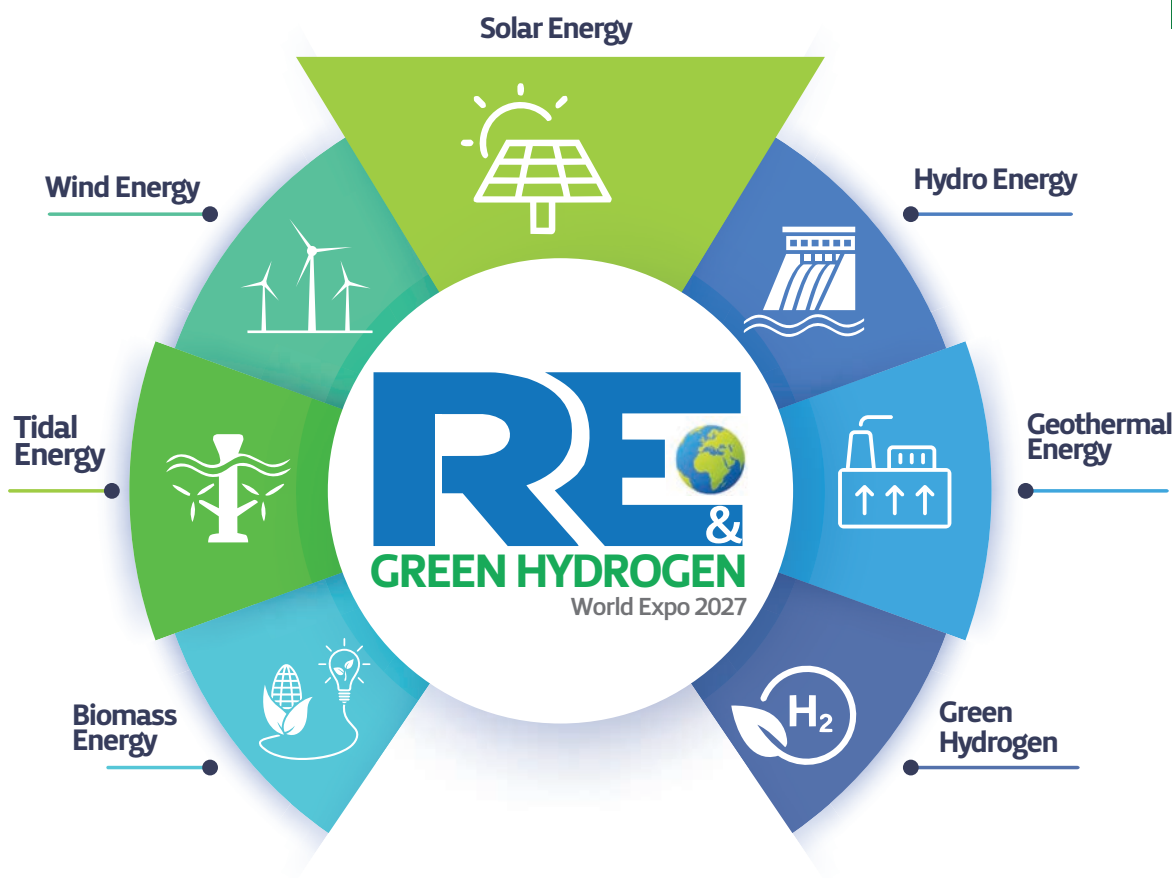
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