Vol. 01 | Issue 04 | JUNE 2025

www.machineedgeglobal.com

MACHINE EDGE GLOBAL

Navigating the Cutting Edge of Industry News

EVENT REPORT
Avener Capital

MARKET AND STRATEGY
Bosch Global Software Technologies (BGSW)

VOICES OF INDUSTRY
Bry-Air

IN THE HOT SEAT

DIMITROV KRISHNAN

Managing Director of Volvo Construction Equipment India

Handling Systems for Clean Rooms and Hygienic Areas.

Our hygienic vacuum tube lifters and crane systems are perfect for industries demanding heightened cleanliness levels like pharmaceuticals, healthcare, and food processing. They are easy to clean, minimize contamination risks, and preserve the integrity of handled goods

WWW.SCHMALZ.COM
T: 020 69115500
Schmalz India Pvt Ltd . EL 38, J Block, MIDC, Bhosari, Pune 411026 .
schmalz@schmalz.co.in

Scan to Enquire

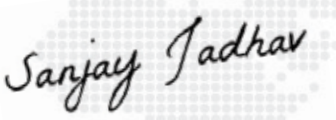
Automation Nation: How India Is Rewiring Its Manufacturing Future

Industrial automation, once considered a supplementary enhancement in Indian manufacturing, has firmly established itself as a strategic necessity. With rising production costs, growing demands for higher-quality output, and stiff competition from countries like China and those in Southeast Asia, Indian manufacturers are embracing automation not just to improve efficiency, but to thrive in an increasingly demanding global market.

India's manufacturing landscape is undergoing a significant transformation, catalysed by economic reforms, digital advancements, and a global movement towards supply chain diversification. With this momentum, the country is rapidly emerging as a preferred global manufacturing destination, drawing both foreign and domestic investments. According to recent industry projections, India's automation sector is expected to reach USD 17.28 billion by 2025, with an anticipated CAGR of 14.26% through 2030—pushing the industry size to an estimated USD 33.64 billion. This robust growth is being powered by the adoption of Industry 4.0 practices, smart factory initiatives, and various government-led reforms aimed at boosting manufacturing capabilities. A major share of this progress can be attributed to the workforce that powers the industry—engineers, developers, technicians, and visionaries who are redefining the future of automation in India.

In this issue, we bring exclusive insights from industry leaders. We speak with Dimitrov Krishnan, Managing Director of Volvo Construction Equipment India, who elaborates on India's evolving infrastructure landscape and Volvo's mission to drive sustainability and innovation in construction through electrification and engineering excellence. Additionally, Guru Mallikarjuna, Senior Vice President, Mobility Solutions at Bosch Global Software Technologies (BGSW), shares his perspective on Software-Defined Vehicles (SDVs), the rising influence of artificial intelligence in mobility, clean powertrain transitions, and the criticality of cybersecurity in future automotive solutions. Our current edition also includes a wide array of insightful articles across manufacturing and automation domains—stories that matter, innovations that inspire, and people who make it all possible.

At Machine Edge Global, our mission is to spotlight transformative ideas and the unsung heroes driving the evolution of manufacturing. As automation becomes the cornerstone of industrial growth, we remain committed to delivering compelling stories, industry voices, and thought leadership that resonate with both B2B and B2C audiences across sectors.



Sanjay Jadhav
Founder & Editor
editor@machineedgeglobal.com

CONTENTS

IN THE HOT SEAT

Dimitrov Krishnan, Managing Director of Volvo Construction Equipment India 04

Exclusive interview with Dimitrov Krishnan, sharing his insights on the evolving landscape of India's infrastructure and construction equipment sector. Also n discussing growth opportunities, industry challenges, and the transformative potential of technology over the next five years, both in India and globally

MARKET AND STRATEGY

Guru Mallikarjuna, Senior Vice President, Mobility Solutions, Bosch Global Software Technologies (BGSW) 10

Interview with Guru Mallikarjuna, sharing his vision for the future of mobility and how bold thinking and digital transformation will define the vehicles of tomorrow.

RENEWABLE INDIA RISING

Power Transmission In India 16

A research report on Enabling India's Energy Transition by Avener Capital

40

VOICES OF INDUSTRY

How Air-to-Water Generators Can Fuel India's Green Hydrogen Vision 36

This article explores how AWG can play a transformative role in supporting sustainable and ethical green hydrogen production in India.

Lightweight, HighPerformance, and Aesthetic: ACPs as the Backbone of Modern Architecture 40

This article explores how ACPs are redefining the building envelope and becoming the backbone of India's high-performance, future ready infrastructure.

The Future of Floating: Digital, Green, and Deepwater Ready 44

This article explores how cutting-edge technologies are shaping the future of floating production and redefining the offshore energy landscape.

How Sustainable Cooling Can Redefine Urban Climate Action 48

This article explores how sustainable cooling solutions, particularly District Cooling, offer a transformative approach to urban climate action—reducing greenhouse gas emissions, easing energy loads, and building more resilient, livable cities for a warming world.

Robotics in Metal Cutting: The Rise of Fully Automated Fabrication Lines 52

This article explores how the fusion of advanced cutting technologies with robotic systems is revolutionizing metal fabrication, boosting productivity, enhancing safety, and paving the way for the future of smart manufacturing.

Company Index/Imprint 56

“Over the next 5 years, the construction equipment industry is expected to undergo significant transformation both globally and in India”

In this exclusive interview with **Machine Edge Global, Dimitrov Krishnan, Managing Director of Volvo Construction Equipment India,** shares his insights on the evolving landscape of India’s infrastructure and construction equipment sector. With a legacy rooted in engineering excellence and a strong commitment to sustainability, Volvo CE is not only shaping the future of construction through innovation and electrification but also playing a pivotal role in India’s development story. Krishnan discusses growth opportunities, industry challenges, and the transformative potential of technology over the next five years, both in India and globally.

Q. Volvo CE has long been recognised as a leader in the construction equipment industry. How would you describe its journey and legacy in India so far?

Volvo Construction Equipment's journey in India has been one of innovation, trust, and sustainable progress, with deep commitment to the country's growth story. Volvo CE India, with over 25 years of local presence and backed by more than 180 years of global engineering excellence, has played a pivotal role in shaping the nation's infrastructure. We were among the first to introduce fuel-efficient excavators and advanced telematics, transforming productivity and operational efficiency. A key milestone was being the first in India to launch electric construction equipment, reinforcing our commitment to sustainability. Our Peenya plant in Bangalore has become a global manufacturing hub, delivering world-class machines for domestic and international markets. From mining to road construction, our equipment has powered some of India's most ambitious infrastructure projects.

With a wide service network, strong customer focus, and future-ready technology, we continue to be a trusted partner in India's growth journey—driving innovation, safety, and sustainable progress in construction.

Q. How would you assess the current state of India's construction and infrastructure equipment market? What are the major growth drivers fueling demand in this sector today?

India's Construction Equipment (CE) industry is experiencing robust growth, with projections indicating a market size of $25 billion by 2030, growing at a CAGR of 12% .This expansion is fueled by substantial infrastructure investments, including the National Infrastructure Pipeline (NIP), which envisions over $1.4 trillion in investments by 2025. Key growth drivers include urbanisation, industrialisation, and government initiatives like Smart Cities and Housing for All. The CE market encompasses a diverse range of machinery, with earthmoving equipment dominating the segment. The industry's growth is further supported by the increasing availability of financing options and a focus on technological advancements to meet the demands of modern infrastructure projects.

Q. Road development is a key priority for the government. What role is Volvo CE's compaction business playing in building better Indian roads?

Volvo CE plays a significant role in India's road development

“Volvo CE is leading the shift toward electric and low-emission construction by being the pioneers of introducing electric construction equipment in India, and setting a new benchmark for sustainability in the industry.”

initiatives through its advanced compaction equipment.

The company's range of compactors is designed to meet the diverse requirements of road construction projects, ensuring high-quality and durable road surfaces. By incorporating features like intelligent compaction systems and fuel-efficient engines, Volvo CE's compactors contribute to faster project completion and reduced environmental impact. Their equipment supports the government's focus on expanding and modernizing the road network, thereby facilitating improved connectivity and economic growth. Volvo CE's commitment to innovation and quality underscores its contribution to building better roads in India.

Q. Sustainability is becoming central to CE innovation. How is Volvo CE contributing to the global and Indian shift towards electric and low-emission construction equipment?

Volvo CE is leading the shift toward electric and low-emission construction by being the pioneers of introducing electric construction equipment in India, and setting a new benchmark for sustainability in the industry.

Globally, we've committed to making our entire product range fossil-free by 2040. In India, our electric machines support the nation's green infrastructure goals, offering zero-emission, low-noise solutions ideal for urban and sensitive environments—paving the way for cleaner, more sustainable construction. By investing in research and development, Volvo CE continues to innovate and offer solutions that meet the evolving needs of the industry while prioritizing environmental responsibility.

Q. What challenges do you foresee in the electrification journey, especially in a diverse and demanding market like India?

The diverse and demanding operating conditions across the country require machinery that can perform reliably in various environments. Additionally, the lack of widespread charging infrastructure poses a hurdle for the adoption of electric equipment.

High initial costs and limited awareness about the benefits of electric machinery further impede progress. To overcome these challenges, a collaborative approach involving government support, infrastructure development, and industry innovation is essential. By addressing these issues, India can accelerate the transition to sustainable construction practices and reduce the sector's environmental impact.

Q. How do you see the construction equipment industry evolving in the next 5 years, both globally and in the Indian context?

Over the next five years, the construction equipment industry is expected to undergo significant transformation both globally and in India. In India, the market is projected to reach $25 billion by 2030, driven by infrastructure development and government initiatives. Globally, the industry will likely see increased adoption of electric and autonomous machinery, integration of advanced technologies, and a focus on sustainability. In India, the emphasis will be on developing equipment suited to local conditions, enhancing manufacturing capabilities, and building a skilled workforce. The industry's evolution will be shaped by the need for efficiency, environmental responsibility, and the ability to meet the complex demands of modern infrastructure projects.

“The future of mobility is incredibly exciting due to the convergence of several transformative trends”

The automotive world is at the brink of a software-led revolution, with emerging trends like autonomous driving, electrification, and connected ecosystems reshaping how we perceive mobility. At the forefront of this transformation is Bosch Global Software Technologies (BGSW), playing a pivotal role in building smarter, safer, and more sustainable mobility solutions.


CH
ộc sống

In this exclusive interview of **Machine Edge Global** with **Guru Mallikarjuna, Senior Vice President, Mobility Solutions, Bosch Global Software Technologies (BGSW),** delves into Bosch's strategic approach to Software-Defined Vehicles (SDVs), the role of AI in next-gen mobility, the transition to clean powertrains, and the evolving cybersecurity landscape. With deep insights into how BGSW is contributing to global innovation from its India operations, Guru Mallikarjuna shares his vision for the future of mobility and how bold thinking and digital transformation will define the vehicles of tomorrow.

Q. The automotive industry is undergoing a transformation with increasing emphasis on smart, connected, and electric mobility. How is Bosch positioning itself in this evolving landscape?

With its 'Invented for Life' ethos, Bosch is committed to shaping the future of mobility—making it safe, sustainable, and exciting for users. The vehicle of the future will be driven by software and will be Personalized, Automated, Connected, and Electrified (PACE). Bosch is focusing on Advanced Driver Assistance Systems (ADAS) and integrating AI capabilities to enable seamless connectivity and personalized experiences. We are also driving the transition toward Software-Defined Vehicles (SDVs) through high-performance vehicle compute and fusion solutions. We believe in Electric Vehicles, and it goes quite well together with connected solutions such as Battery-in-the-Cloud and various smart charging solutions. Collaboration is key—we are partnering across the ecosystem to leverage synergies, share learnings, and develop smarter, more efficient products making lives safer and more convenient with AI-led software. While it is clear that there is a long way to go, we are confident that we're headed in the right direction.

Q. The shift from hardware-centric vehicles to Software-Defined Vehicles (SDVs) is reshaping the automotive industry. How is BGSW contributing to this transformation?

Software is becoming the key differentiator in the vehicle of the future; as software gets increasingly abstracted from the hardware and as we move up the value chain, we see clever application functions & data driven services playing a key role in the Mobility of the future. At BGSW—the software powerhouse of Bosch—we contribute across multiple value dimensions: efficient engineering, innovation, local market access while being able to learn from across geographies; it is driven by an entrepreneurial mindset through ventures and value foldback to the market and across the business units. For example, our Fusion Platform integrates ADAS and infotainment domains onto one high-compute – this is a clear enabler for SDVs and is the right step towards the SDV transformation with fusion bringing significant TCO (Total Cost of Ownership) benefits to the OEMs. Vehicles would be updated with just the deployment of software over the air.

We're also advancing cockpit technologies with solutions around Android-based architectures that allow integrating apps on the fly—complementing solutions like Connected Vehicle Solutions (CVS). Furthermore, software has the capability to improve user experience greatly – a notable example is EVOCO (Emotion Aware Cockpit Companion), an intelligent in-car personal companion that understands user emotions via voice and facial expressions and offers personalized responses bringing human compatibility closer in vehicles. With Vision, voice & text pre-integrated and GenAI backing open conversation, EVOCO goes beyond to model and perform based on behaviour

models and helps human digital life to continue seamlessly across the home, office and vehicle journeys – taking personalization to the next level.

In addition, it is important to develop and deploy according to the market speed as the development cycles are shrinking day-by-day. Virtualization & Simulation is a key enabler to stay abreast with the market speed and position ourselves as a strong Regional Player for Bosch.

Q. AI is driving significant disruption in mobility, from autonomous systems to predictive maintenance. What is the most exciting AI-driven advancements in mobility that you foresee?

AI is revolutionizing mobility—from replacing physical sensors with AI models to enhancing sustainability and efficiency. Predictive maintenance of critical components like injectors is one area where AI brings tangible value. AI also plays a crucial role in design simulations, plant operations, and supply chain optimization.

Autonomous driving is real and is here, evolving in various forms. With generative AI, synthetic data can be created to train models across varied scenarios, accelerating development. As vehicles become more connected and personalized, AI-powered digital companions will assist users by planning their day and navigating seamlessly, allowing them to focus on more meaningful tasks. In Product/Software R&D, AI is being integrated throughout the development lifecycle—serving as an expert peer-assistant to our experts & engineers, improving both speed and cost-efficiency. There is no doubt that there will be a significant disruption in the way we look at Mobility and it is quite evident in today's evolving scenarios.

Q. As global regulations push for lower emissions, automakers are diversifying powertrain technologies. What role does BGSW and Bosch play in this transition?

At Bosch, sustainability is a core value. We are advancing a broad range of powertrain technologies to meet consumer expectations and regulatory mandates. Our focus spans battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs), while continuing to improve internal combustion engines (ICEs) with alternate fuels and biofuels.

We believe that technology diversity is key to achieving clean, green, and safe mobility across segments and markets. Using data analytics, predictive maintenance, and vehicle calibration, we help optimize powertrain performance. Market pulls, customer preference, government policies and infrastructure development will ultimately decide actual deployment. For instance, in India, Hydrogen ICEs—especially for heavy-duty vehicles—present a promising path, supported by the National Hydrogen Mission. Bosch is actively collaborating with ecosystem to bring these innovations to life, and is participating in industry forums to shape future standards.

Q. GCCs in India are becoming crucial in automotive R&D and digital transformation. How does BGSW contribute to global mobility innovation through its GCC operations?

As a Global Capability Center (GCC), BGSW is committed to creating value through innovations, topic ownership, regional entrepreneurship, and product leadership – through key levers like local-to-global leadership, alignment to the global strategy, and developing strong talent. The BGSW Value journey can be seen through the lens of the axes of leverage like our engineering prowess, leveraging regional strengths, co-innovation and entrepreneurship by creating a digital edge, building up future talent, exploring co-innovation opportunities, and more.

One of BGSW's key value propositions is the ability to translate local market insights into global innovation and vice

versa, owing to the fact that we work on topics across geographies. This also opens up new growth opportunities in local & emerging markets. BGSW with its Global Delivery Network beyond India, helps stay close to the market and the customer, enabling nearshore operations that serve customers more effectively. An entrepreneurial mindset is central to our approach, helping us push boundaries and shape the industry through digital and engineering excellence.

Q. With software-defined vehicles becoming more connected, cybersecurity threats are a growing concern. How is BGSW/Bosch addressing these challenges?

As vehicles become more connected through technologies like V2X, the number of potential attack surfaces also increases. For Example, features such as Plug-and-Charge demand secure payment mechanisms. Our products are built with cybersecurity in mind. There is no doubt that there is no safety without security.

We address cybersecurity challenges through a multi-layered security approach which encompasses both vehicle hardware and software security through Hardware Security Modules (HSMs), software signing, Secure Onboard Communication, and Over-The-Air (OTA) updates. We also containerize safety-critical software from QM (Quality Management) components to avoid compromise.

BGSW follows a rigorous Security Engineering Process (SEP), including regular assessments such as TARA (Threat Analysis and Risk Assessment) and secure coding & testing practices – with our experts spanning across domains taking care of compliance to product security at Bosch through means of various security building blocks. We provide chip-to-cloud cybersecurity across niche domains where IT, OT, and IoT systems converge. We cover pre-market assessments, concepts, validation, and post-market managed services. We stay ahead of emerging threats through continuous threat intelligence monitoring, ensuring that our products are not only innovative but also resilient and secure.

Q. What excites you the most about the future of mobility, and what is your vision for BGSW's contribution to this transformation?

The future of mobility is incredibly exciting due to the convergence of several transformative trends. In the age of AI & GenAI, I am excited to see how we can transform the industry. At BGSW, we are building an AI-first culture to drive both innovation and efficiency. We see software as a key differentiator and are poised to lead a paradigm shift in automotive engineering. This transformation demands courage to disrupt the patterns of the past and embrace the future with agility.

Through bold thinking, talent transformation, and entrepreneurial leadership, we're not just participating in the mobility revolution—we're actively shaping it.

INDIA'S ONLY LISTED
METAL COMPOSITE BRAND WITH A DIVERSE EXPERIENCE OF
MORE THAN 2 DECADES!

3 COAT 2 BAKE COATING LINE
CONTINOUS ADVANCED LINE
INFINITE COLOR CUSTOMISATION

65,00,000+ M² OUTPUT
1.8+ MIL. ORDERS EXECUTED
300+ DESIGNS

25,000 M² DAILY OUTPUT
5 PRODUCTION LINES
IN-HOUSE TESTING LAB

8 ACRE PLANT
SOLAR POWERED
IGBC CERTIFIED

Euro Panel Products Limited
+91 022 2968 6500, +91-7666625999
sales@eurobondacp.com | www.eurobondacp.com

KNOW MORE

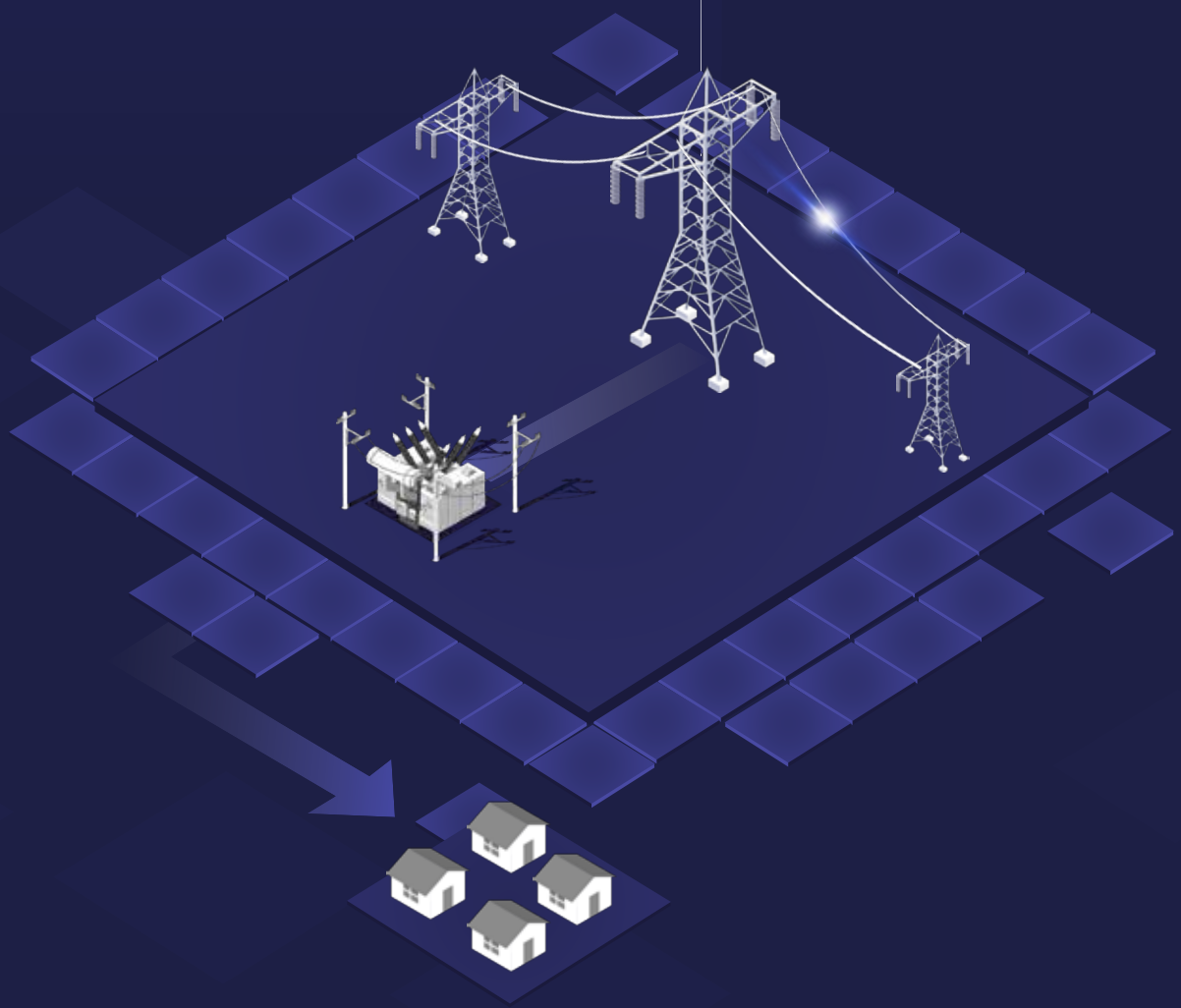
Power Transmission In India

Enabling India's Energy Transition

Industry Report
by Avener Capital

CONTENTS

The India Opportunity 19
Operating Mechanics 23
Risk & Return Dynamics 25
Capitalizing on the Opportunity 27
Market Mapping 29
Global Outlook 32

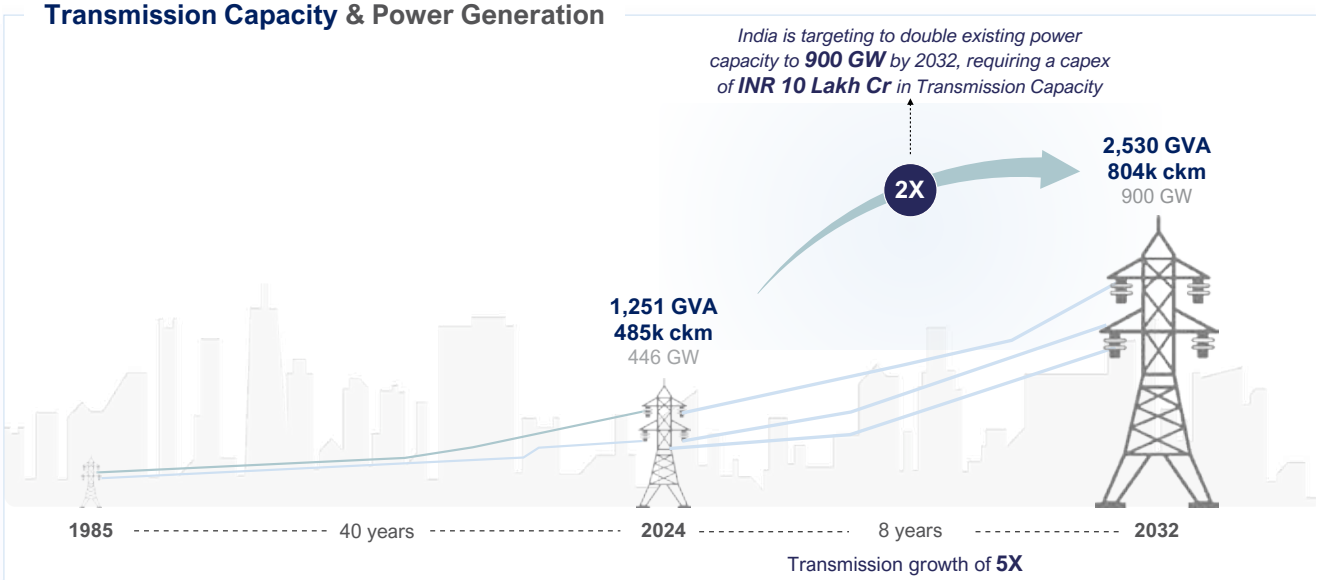


THE INDIA OPPORTUNITY

Power Transmission at an Inflection Point

Foundation to achieve India's energy & sustainability goals

Transmission Capacity & Power Generation



India's Energy Goals Driving the Unprecedented Growth in Power Transmission

- One Grid, One Nation
- Energy Independence by 2047
- Net Zero by 2070

Source: CEA, Avener Estimates

5X Accelerated Growth

₹10 Lakh Cr Opportunity

90%+ TBCB (PPP)

Evolution of Regulatory Framework (1/2)

Regulatory environment for transmission has evolved to encourage investment and expertise from private sector

Electricity Act — 2003

- Unbundling & corporatization mandated creation of SERCs
- Open access in T&D sector
- Power trading & captive generation encouraged

National Tariff Policy — 2006

- Competitive bidding transmission (TBCB) & power procurement
- Cost plus regulated returns under generation, transmission and distribution

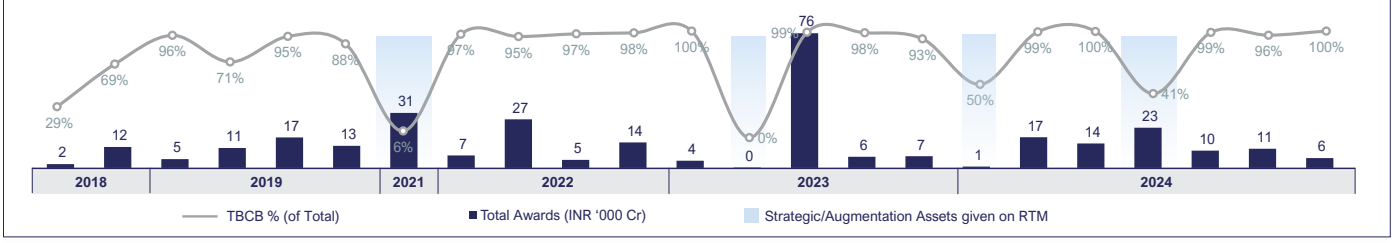
Governance — 2015

- Creation of regional MoEF for grant of forest clearance
- Right of way (RoW) compensation guidelines and RoW committee formed
- National committee of transmission formed in 2018

TBCB Guidelines — 2021

- **All projects to be done on TBCB – BOOT basis**
- **Claims automation**
- Promote competitive procurement & encourage private investment
- Facilitate transparency & fairness in procurement amongst bidders

TBCB over the years



As per Minutes of NCT meetings

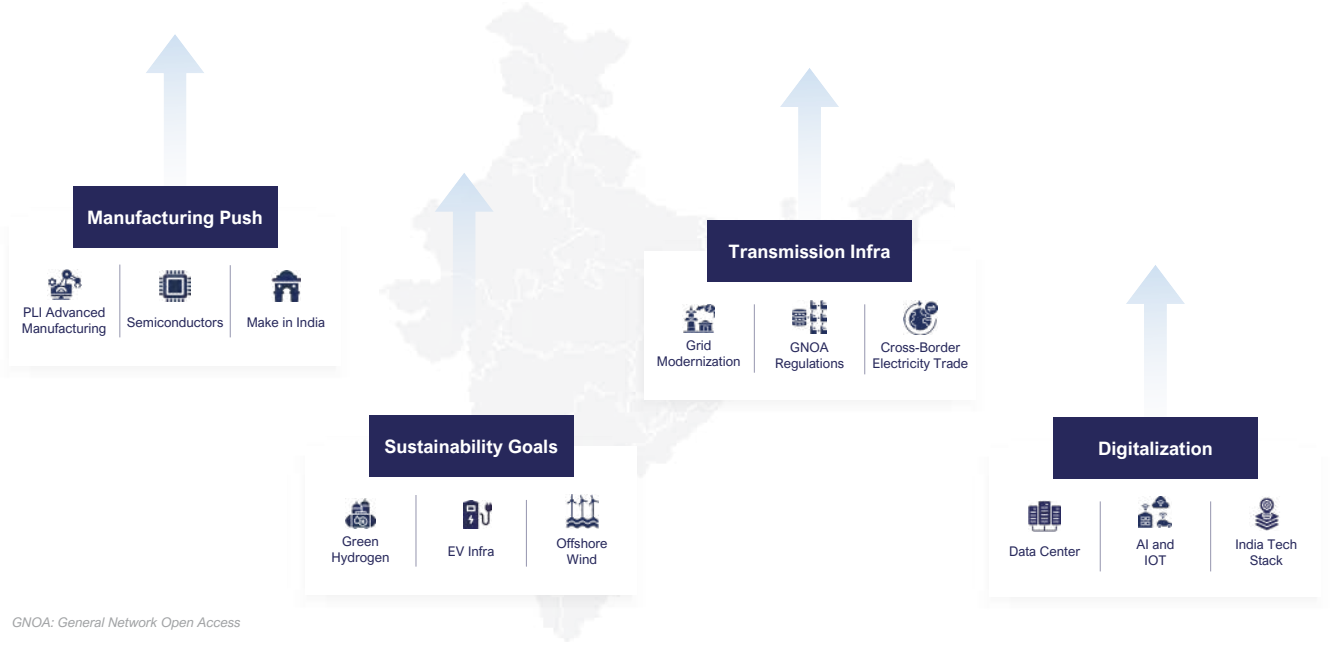
Evolution of Regulatory Framework (2/2)

Regulatory environment for transmission has evolved to encourage investment and expertise from private sector

- Improved price discovery
- Fiscal prudence since ownership is with developer
- Fixed timeline/ tariff incentivizes timely execution
- Annuity type revenue provides higher comfort for project funding
- Attracts foreign investment
- Technological advancements
- Quality of assets enhanced

Growth Drivers for Power Transmission in India

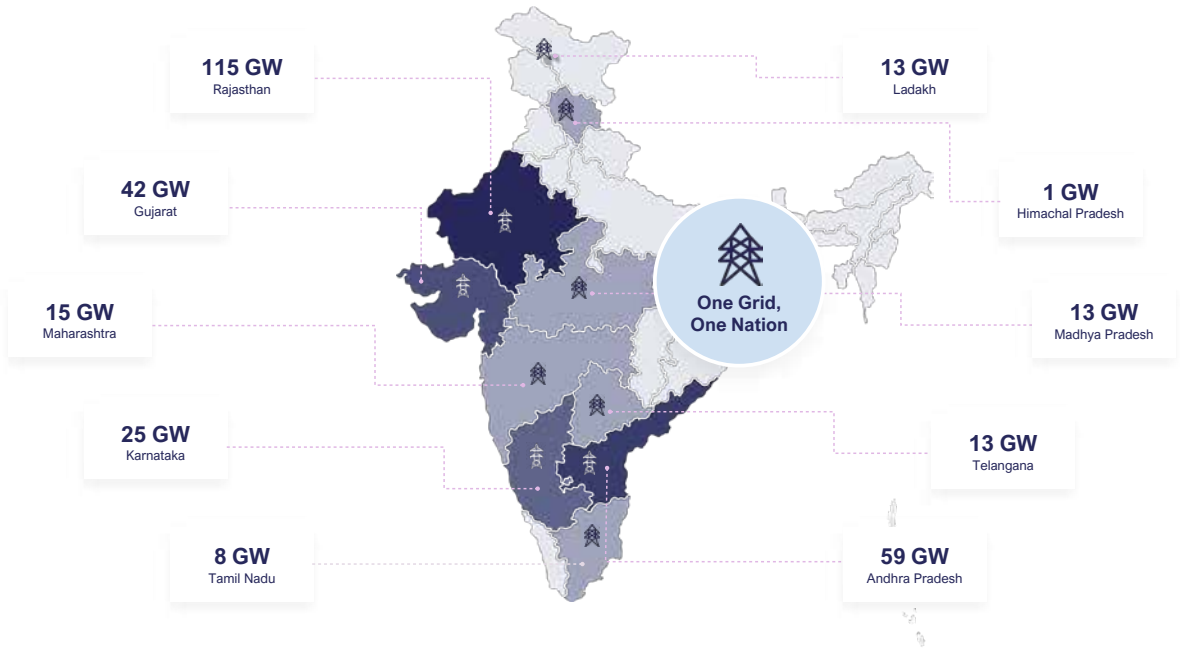
Exponential increase in electricity demand will drive the growth of power transmission



GNOA: General Network Open Access

India Plans Renewable Energy Addition of 300+ GW by 2032

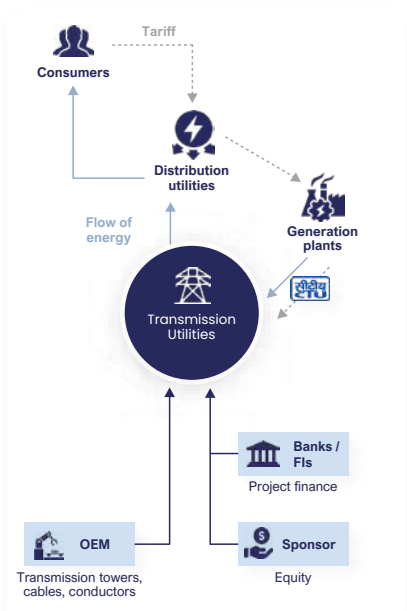
Energy independence by 2047 and net zero by 2070 will require a robust power transmission infrastructure in India



Operating Mechanics

Value Chain & Project Lifecycle

Critical elements over the asset life of transmission projects



Bidding	<1 year	Bid process	• Appointment of a bid process coordinator by NCT • Conducting a 2-stage bid process by BPC • Selection of successful bidder • Issuance of letter of intent • Signing of the TSA with LTTCs • Transferring SPV by BPC to *Selected* bidder
Planning	0.5 year		
Construction	3 year	Pre-construction activities	• Obtain transmission license • Obtain order for adoption of transmission charges • Submit project execution plan to CEA and LTTCs • Conduct the check survey • Apply/ obtain relevant approvals & clearances • Complete the designs of components • Achieve financial closure
		Construction activities	• Laying of foundations • Erection of towers • Stringing of lines • Construction of sub-stations • All approvals must be in place
		Commissioning	• Notify the RLDC, CTU/STU and LTTCs its intention to commission the line/ elements • Meet the grid code for the line requirements • Obtain approval from electrical inspector • Obtain COD after continuous operation for 72 hours
Operational	35 year	Post COD	• Maintain availability as per TSA (Most assets operate at ~100%) • Monthly invoicing to CTU
		Financial reengineering	• Regearing • Reduction in debt cost by 100 bps • Monetization can also be explored
		End of Contract Life	• BOOT (Transferred at end of 35 years to BPC) • BOOM (Ownership continues with developer and further contract period could be explored with LTTCs)

Key Considerations for a Power Transmission Project

Determination of Capex & Tariff involves comprehensive assessment of various factors

Tariff Discovery

Lowest Tariff

Comprises of Annual Fixed Tariff (95%), Escalable Tariff (2%), Incentives linked to Availability (3%)

IRR Expectation

The tariff is based on IRR expectation over a long transmission service period vs the estimated capex

Capex Split

Land Acquisition Cost

For substations and transmission lines in rural vs urban areas

Equipment Cost

Includes transformers, conductors, towers, insulators and other hardware

Technology and Automation

SCADA systems, smart grids and other enhancements

Specifications

Voltage Level

Higher voltage transmission lines (e.g., 765 kV, 400 kV) entail increased equipment costs & stringent safety norms

Distance

Longer transmission lines require more infrastructure (towers and conductors)

Terrain and Geography

Complex geography involve specialized equipment, longer capex periods, environmental mitigation measures

O&M

Operational Costs

Staff, monitoring, repairs, insurance and scheduled maintenance of equipment to ensure availability

Optimization

Cost can be optimized through new technology (such as drones)

Other Factors

Environmental/ Social Costs

The cost of obtaining environmental and forest clearances

Inflation

The rise in costs of materials, labor and other inputs

Forex Impact

Currency fluctuations can adversely impact cost of capital and other costs

Salient Features of the Transmission Service Agreement

Key terms governing a transmission service agreement between LTTCs and project developer

Features	TSA terms for BOOT asset		
Contract Period	Valid for **35 years** from SCOD of substations & transmission lines	Transmission license valid for **25 years** from COD which can be renewed	
Tariff Price and Incentives	Quoted transmission charges **(~98.5% of total tariffs)**	**Upto ~1.5% of total tariffs**, availability linked incentive payments above target availability	
Performance Security	Contract performance guarantee **~2-5%** of TPC to be deposited by the transmission service provider in favor of CTU		
Implementation Schedule	Project will take approximately **18-38 months** to get completed from the effective date		
Force Majeure	For **INNFME & NFME**, TSP is entitled to payment for debt servicing	For **DNNFME**, TSP is entitled to non-escalable transmission charges provided such force majeure event has been ongoing for 3 months	
Damages / Penalties	**3.33%** of monthly transmission charges for delay of 60 days, **5%** thereafter if SPV fails to achieve SCOD on time	Availability **<95%**, TSPs shall pay penalty as per TSA	Delay of **>6 months** from SCOD results in event of default and TSA can be terminated
Termination Payment	Termination on account of Force Majeure events, non-requirement of any element or project during construction, Nodal Agency's non-fulfilment of role & TSP's event of default, TSP shall be entitled for termination payment equivalent to valuation of project assets. Upon payment, the Nodal Agency shall take over the project assets		
CIL Claims	TSA provides pre-defined formula for increase in transmission charges corresponding to increase in project costs for Change in Law		

DNNFME: Direct Non-Natural Force Majeure Event | INNFME: Indirect Non-Natural Force Majeure Event | NFME: Natural Force Majeure Event

Risk & Return Dynamics

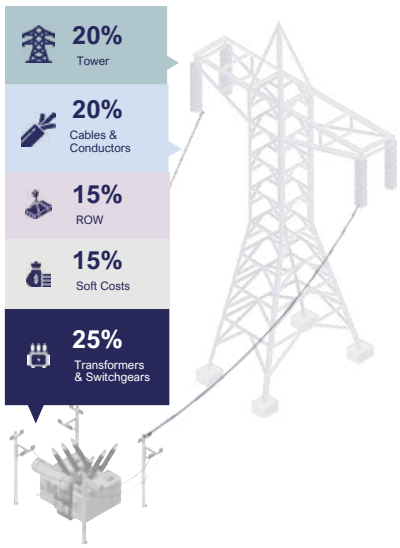
Returns, Risks & Mitigants

Evaluating the value pockets of power transmission ecosystem

	Developer	EPC	OEM
Average returns	16% HTM IRR; 40% Exit IRR	10% EBITDA margin	10% EBITDA margin
Risks	Financing; Overruns; O&M; Force majeure	Execution; Commodity prices; Working capital; Orderbook	Commodity prices; Inventory obsoletion; Working capital; Orderbook
Mitigants	Mature Credit + Secondary Market; Claims Mechanism; 97-98% EBITDA; Deemed Availability (under TSA)	Capabilities; Hedging; Contracts with Leading Developers; Large Capex Pipeline	Lower Lead Time; Stable Sector; Contracts with Leading Developers; Large Capex Pipeline

Approximate returns and margins

Project Cost



Unlocking Value through Cap Rate Compression

Long life of a power transmission project enables financial reengineering and serves as an IRR protection mechanism

Upfront Financing

Timeline	Pre-construction
LTV	75-80%
DSCR	1.30x
Interest rates	10Y G-sec + 250-300 bps
Loan tenor	25-28 years
Credit rating	A

Optimization/ Regearing

Timeline	Post completion
LTV	85-90%
DSCR	1.15x
Interest Rates	10Y G-sec + 150-200 bps
Loan Tenor	30 years (excl 15% tail)
Credit Rating	AA

InvIT Monetization / Cash Pooling

Timeline	Completion + 1 year
DCF	11-12%
Credit Rating	AAA

16% HTM IRR + 24% Monetization at 12% = 40% Exit IRR

Capitalizing on the Opportunity

Key Strategies Shaping India's Power Transmission

Market players are strategically evolving to capitalise on the unprecedented growth opportunity

	Asset Ownership **Developers**	Service **EPC**	Product **OEM**
Erstwhile Strategy	• Bid for new projects • Infuse capital for project execution • Monetization through InvIT/ Sale on completion • Reinvest for future projects	• Execute projects for developers • Gradual increase in the orderbook based on pipeline	• Delivering products to the developers/EPC players • Gradual increase in the orderbook based on pipeline
Triggers	5x Capex Pipeline	Evolution of the secondary market	
Emerging Strategy	• **Recurring financial partner for capital infusion** • Reinvest developmental margins • Build scale over next 5-8 years • Unlocking value through IPO/ InvIT	• Build bidding capabilities to become a developer • **Initiate with developmental projects of capex INR ~500 Cr** • Forward purchase agreements with InvITs	• **Build execution capabilities to become an EPC player** • Increase capacity

Market Mapping

Value Chain

An efficient transmission operating system comprises of seamless integration amongst EPC players, developers and OEMs

Tower manufacturer	SKIPPER, SALASAR, UTKARSH, TRANSRAIL, ELECTROTHERM, DICABS
Transformer	TBEA, GT, VOLTAMP, transformers & rectifiers (India) Ltd, RMC, TOSHIBA, ABB
Cables & conductors	APAR, POLYCAB, KEI Wires & Cables, TAG, LUMINO, jyk, GUPTA POWER
Switchgear	Schneider Electric, SIEMENS, NUCON, Hitachi Energy, Hind Rectifiers Limited, CABCON, MEGAWIN
EPC	KALPA TARU, KEC, L&T, MONTECARLO, STERLING & WILSON
Developer	POWERGRID, adani Energy Solutions, Sterlite Power, TATA POWER, APRAVA ENERGY, ReNew POWER, torrent POWER
InvIT	IndiGrid, AnZen, PGInvIT

Recent Deals in Power Transmission

Market participants have been raising capital in anticipation of the upcoming capex pipeline

	Aug'24	Aug'24	Aug'24	Jul'24	Jul'24	Jun'24	Mar'24	Mar'24
Target	IndiGrid	IndiGrid	IndiGrid	adani Energy Solutions		transformers & rectifiers (India) Ltd	Sterlite Power	EMC Limited
Deal Type	Pref Issue	JV	OFS	QIP	QIP	QIP	JV	M&A
Deal Size	667	2,000	1,800	8,300	1,250	500	4,200	178
Investors	AIMCo, HDFC Life	British International Investment, Norges Bank Investment Management	Multiple Investors	ADIA, QIA	Multiple Investors	Multiple Investors	GIC	Salasar
Remarks	Towards repayment of debt and expansion	Co-Development of under construction assets	KKR sold 17.3% unit stake in IndiGrid	Transmission capex, deleveraging, smart meters	EPC works for transmission projects, AMI solutions and data centers	Growth capex, deleveraging, M&A	India's maiden transmission development platform	Acquisition of manufacturing and EPC capabilities
Growth Capex		✓	✓		✓	✓		✓

Recent Deals in Power Transmission

Market participants have been raising capital in anticipation of the upcoming capex pipeline

	Nov'23	Nov'23	Sep'23	Dec'22	Nov'22	Aug'22	Apr'21	Jan'20
Target	APAR	Khargone TL, Sterlite Power	$KIPPER	Rajgarh TL, GRIL		SALASAR	GRIL	Sterlite Power
Deal Type	QIP	M&A	Rights	Forward SPA	PE Sale	QIP	IPO	PE
Deal Size	1,000	1,500	200	430	115	82	968	1,000
Investors	Multiple Investors	IndiGrid	Multiple Investors	IndiGrid	Nalanda Capital	Multiple Investors	Multiple Investors	AMP
Remarks	Working capital	Acquired operational asset from Sterlite Power	Growth capex, working capital	Forward purchase agreement with G R Infra Ltd	Nalanda India fund exits post Investment in FY14	Towards repayment of debt, working capital	Exit for investors like Blackrock, Smallcap World Fund	Growth capex for setting up power transmission projects
Growth Capex		✓	✓	✓		✓		✓

Key Emerging Players in the Transmission Sector

Massive capex pipeline is resulting in rapid scaling up by existing as well as new players

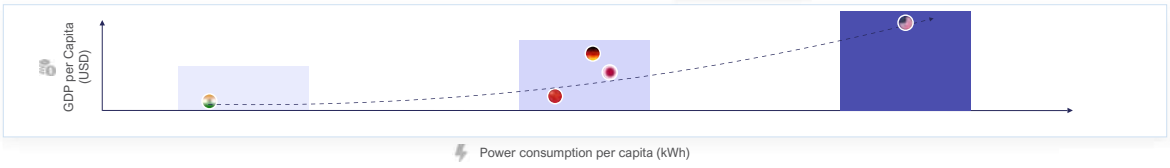
Companies	Description	Scale	Market Cap	Order Book	Revenue FY24	EBITDA FY24	Net Debt FY24	Rating	Shareholding	Key Highlights
APAR	EPC/ Manufacturing of TL, cables, conductors, specialty oils, telecom solutions	Turnkey: 165+ Conductors: 2L MT	40,000	8,300	16,153	10%	-	ICRA A+	Promoters: 58% FII: 12% DII: 18%	Apar's order book in cable & conductor business crosses INR 8,300 Cr
APRAVA	Thermal, solar and wind generation, power transmission and smart metering assets	Generation: 3.2 GW Tx: 1,000 MVA Smart Meters: 4.7 Mn	N/A	N/A	5,581 (FY23)	29%	5,366 (FY23)	IND AA+	CLP: 50% CDPQ: 50%	Won 4th ISTS TBCB of TPC INR ~2,200 Cr in Apr'24, other projects (TPC INR ~2,000 Cr)
BAJEL	Turnkey EPC for transmission & distribution	TL Cumm: 7,900 ckm Tx Cumm: 2,000 MVA Mfg Cumm: 33K MT	2,940	3,598 2,267*	1,169	1%	-	CRISIL A1	Bajaj Electricals: 63% FII & DII: 8%	Won TL orders from PGCIL worth INR 587 Cr in Jul'24
GRIL	EPC & Infra Co focused on roads, railways, metro, optic fibers, airports and transmission	Roads: 3,200 km Mfg: 1.4L MT	16,026	14,975 300*	7,788	18%	3,063	CRISIL AA	Promoter: 75% FII: 1% DII: 21%	Won 3rd ISTS TBCB project of TPC INR 800 Cr in Aug'24, other projects recently won (TPC INR ~1,000 Cr)
KALPA-TARU	Turnkey EPC solutions for T&D, buildings & factories, water supply & irrigation, railways, oil & gas pipelines, urban mobility, highways, airports	TL: 1,794 ckm Mfg: 2.4L MT	22,638	57,195 20,597*	19,626	9%	2,878	CRISIL AA	Promoter: 36% FII: 10% DII: 46%	Divested stake in a transmission asset to Apraava energy in Feb'23, Order inflows cross INR 7,000 Cr in Jul'24
KEC	Turnkey EPC in transmission & distribution, railways, civil, urban infra, renewables, oil & gas pipelines, cables	TL: 4,300 ckm Tx: 4,500 MVA Mfg: 3.2L MT	25,176	32,715 16,685*	17,813	5%	3,712	ICRA A+	RPG: 52% FII:13% DII:25%	Secured 1st order for transmission conductors in Mar'24 Divested stake in transmission asset to Adani in Feb'19 Orders cross INR 7,600 Cr in Jul'24
meil	EPC & Infra Co - hydrocarbons, electric vehicles, transportation, power and irrigation	N/A	N/A	1,87,000	31,766 (FY23)	18%	- (FY23)	CRISIL A1+	Promoter: 100%	Recently won 4 InSTS and 2 ISTS projects
MONTECARSC	Construction of roads, railways, transmission projects, mining and quarrying, smart meters	Ongoing projects: 62	N/A	12,000	4,897	489	1,500	CRISIL AA-	Promoter: 100%	Placed a bid for TBCB project in May'24 Awarded 3 smart meters projects by 2024
ReNew POWER	Power generation, energy as a service, manufacturing of solar cells, modules, power transmission	Generation: 15.6 GW Tx: 5,000 MVA	N/A	N/A	8,112	85%	58,212	IND A+	Promoter: 4% CPPIB: 30% ADIA: 23% JERA: 11%	COD for 1st ISTS project in Nov'23 Targeting 50 GW by FY30
SALASAR	EPC, fabrication, manufacturing, contractual galvanization, Sectors: telecom, power, renewables, smart city	TL: 885+ ckm Capacity: 1L+ MT Rail electrification: 695+ km	3,500	2,460	1,208	10%	319	IVR A	Promoter: 57%	Awarded 7 T&D projects of INR ~1,000 Cr by TANGEDCO in Mar'24 Acquired EMC in Mar'24
SKIPPER	Transmission tower manufacturing and EPC line construction	Tower Mfg: 2.1L MT Polymer Mfg: 43K MT	4,740	5,844 3,448*	3,282	10%	442	Acuite A	Promoter: 66% FII & DII: 4%	Rights Issue of INR 200 Cr in Sep'23
TATA POWER	New-age energy solutions, generation, renewables, power transmission and distribution India's largest vertically integrated power company	Generation: 20.2 GW TL: 6,688 ckm Customers: 12.5 Mn	1,41,665	15,640	61,449	21%	40,328	CRISIL AA+	Tata: 47% FII: 10% DII: 15%	Planned capex INR 20K Cr in FY25, Won 2nd ISTS TBCB Project of TPC INR ~2,500 Cr in Aug'24, other projects (TPC INR ~2,000 Cr)
TECHNO ELECTRIC & ENGINEERING CO. LTD	Turnkey EPC for power generation, transmission, and distributions and data centres	# Projects: 450	18,389	9,101 4,889 *	1,502	14%	-	ICRA AA	Promoter: 62% FII: 8% DII: 25%	JV with Indigrid, Norfund and BII to develop 3 ISTS projects in Aug'24 QIP of INR 1,250 Cr in Jul'24 Won 2 ISTS TBCB Projects of TPC INR ~700 Cr in Apr'24, Jul'24
torrent POWER	Integrated power utility in power generation, transmission, distribution, manufacturing and supply of power cables	Generation: 4.3 GW Customers: 4.1 Mn	89,635	N/A	27,183	18%	11,166	CRISIL AA+	Promoter: 54% FII: 8% DII: 20%	Won 1st ISTS TBCB Project of TPC INR ~1,500 Cr in Jun'24 Board approved private placement of INR 8K Cr in May'24

Global Outlook

India's Journey to Become a Developed Nation by 2047

Roadmap to development through estimated capex of INR 110 Lakh Cr

To become a developed nation (~USA) by 2047, India would need to achieve 10x power capacity, resulting in transmission capex of **INR ~110 Lakh Cr**



Avener estimates

Global Investors

Private Equity Investors, SWFs, Pension Funds

GIC · KKR · CDPQ · Ontario Teachers' Pension Plan · actis · Temasek · Stonepeak · OMERS · Blackstone · ARES · John Laing · CPP Investments · Schroders · Meridiam · PIF · Allianz · AMP · ADIA · Brookfield · CIP

DFIs

KfW · ADB · AIIB · Eurasian Development Bank · NIB · JBIC · British International Investment · DFC · Norfund · IFC · JICA

Strategics

elia · Iberdrola · entergy · ABB · NextEra Energy · Invenergy · Hitachi · Pattern · apa · Toshiba · octopus energy · ALSTOM · Kansai Electric Power · Keppel Corporation · Xlinks · KEPCO · Schneider Electric · jera · SIEMENS

Recent Global Deals in Power Transmission

Target	Transgrid	50Hertz	Emera	Avangrid	FirstEnergy	edp	Jersey Link	energyRe
Deal Type	PE	Private placement	PE	M&A	PE	PE	PE exit	PE
Deal Size	570	1,081	890	2,500	3,500	500	N/A	1,200
Investors	cefc	KFW, elia	KKR	Iberdrola	Brookfield	actis	Blackstone Invenergy	Gilentra, nova holdings plc
Remarks	Develop the connector grid from New south wales to victoria (Australia)	Development of transmission assets in Germany	Developing a clean energy transmission project	Strategic acquisition in USA	Strategic partnership for clean energy transition in USA	Investment in Brazilian transmission sector	Strategic exit for Blackstone in USA	To accelerate US clean energy transition
Growth Capex	✓	✓	✓		✓	✓		✓

	Aug'24	Aug'24	May'24	May'24	Mar'24	Feb'24	Dec'23	Dec'23

Deal Size in USD Mn

Recent Global Deals in Power Transmission

Target	Equatorial Energia	ABB	Scottish & Southern Electricity Networks	NeuConnect	Terna	Rampion	evoltz	GridLiance
Deal Type	PE	M&A	Rights	M&A	M&A	M&A	PE Sale	JV
Deal Size	220	7,800	2,000	3,190	292	392	968	178
Investors	CDPQ	HITACHI	Ontario Teachers' Pension Plan	TEPCO Power Grid	CDPQ	AMBER	Ontario Teachers' Pension Plan	Blackstone, NextEra Energy
Remarks	Verene energia, CDPQ's LATAM platform	Enhance Hitachi's global market positioning	Support UK's renewable energy infrastructure	Follow-On power transmission investment by TEPCO in Germany	Creating of CDPQ transmission platform in LATAM	Towards repayment of Debt, working capital	Exit for investors like Blackrock, Smallcap World Fund	Repayment of debt, working capital & growth capex
Growth Capex		✓	✓	✓	✓			✓

	Dec'22	Nov'22	Sep'22	Jul'22	May'22	Nov'21	May'21	Sep'20

Deal Size in USD Mn

Event Brigade

TO YOUR RESCUE

Services we provide:

- Seminars, Conferences & Meetings
- Brand/Product/Factory Launches
- Dealer/Trade/Retailer's Meet
- Customer Dealer Interaction Programs
- Merchandise and In Shop Promotions
- Brand Extention Services
- Annual Celebrations
- Exibitions
- Press Conferences
- Employee Engagement Activites
- Sale, Rental & Installation of Audio Visual Equipments

CONTACT US AT:

+91 90287 55979

office@eventbrigade.in

2nd floor, Swami Shraddha apt, Bavdhan, Pune.

www.eventbrigade.in

How Air-to-Water Generators Can Fuel India's Green Hydrogen Vision

DEEPAK PAHWA,
Chairman, Pahwa Group and Managing Director, Bry-Air

As the global community intensifies its efforts to combat climate change, green hydrogen has emerged as a key pillar in the transition to clean energy. In India, the focus on green hydrogen is gaining momentum through the National Green Hydrogen Mission, aiming to reduce carbon emissions, enhance energy security, and promote economic resilience. Central to this mission is the need for ultra-pure water for electrolysis which is a dire requirement that can be effectively met through innovative solutions like Air-to-Water Generator (AWG) technology. This article explores how AWG can play a transformative role in supporting sustainable and ethical green hydrogen production in India.

As the ramification of climate change intensifies, India is poised to ramp up its Green Hydrogen Mission. With the world seeking sustainable energy solutions to address the issue of global warming and its impact on the environment, green hydrogen emerges as a cornerstone for facilitating a seamless transition to clean energy. It is a source of clean energy that comes with the ability to replace fossil fuels in transportation and industrial processes.

Driving Decarbonization, Energy Security, and Economic Resilience

Green hydrogen plays an instrumental role in decarbonizing the industries by reducing the carbon emissions of the sectors across the country. Additionally, it drives the energy independence of the country by steering away from fossil fuels, significantly contributing to the energy security of the country at the same time. As a result, the advantages of green hydrogen transcend to boosting economic resilience as well, apart from curbing the carbon footprint of the industries.

Why AWG is Essential for Green Hydrogen Production

However, before venturing into the journey, the industry should focus on integrating air-to-water generator (AWG) technology into the production of green hydrogen processes. Here, it is important to understand that the production of green hydrogen involves splitting water into its constituent elements Hydrogen (H2) & Oxygen (O2) with the help of electricity. In the process, it is mandatory to supply ultra pure and clean water to the electrolyser; as a result, though there are many sources of water, deriving clean water from them can be very complicated. On the contrary, AWG is responsible for generating white water, which is 100% pure and clean water. Therefore, water extracted from atmospheric moisture by making use of advanced adsorption technology is preferred for the green hydrogen process.

Comparing Water Sources for Electrolysers

There are many sources of water available for electrolyser, including sea water, river/ lake water, wastewater/ brackish water, groundwater, municipal supply, and white-water generator. Where sea water involves desalination and distillation processes, it uses high amount of energy and is even responsible for producing highly concentrated brine. It is majorly a byproduct of the desalination process which is quite challenging when it comes to disposing it off.

Similarly, river/ lake water undergoes pre-treatment and distillation, utilizing less energy, and faces the challenge of seasonal limitation. In wastewater/ brackish water, there is a need to conduct filtration, reverse osmosis, and distillation, which are huge energy guzzlers and require extensive pre-treatment and produce high waste output.

Likewise, groundwater and municipal supply require filtration and distillation processes that involve lesser utilization of energy. Here, where groundwater causes the depletion of water tables, municipal supply accounts for straining the community resources. Moreover, all the water sources do not conform to net-zero potential and are not ethical at the same time. On the other hand, the white water generator undergoes adsorption process making use of medium energy which supports the net-zero cause and is ethical at the same time. It can generate water by making use of renewable energy and is well adept at extracting even in arid and semi-arid areas round the clock.

India's Advantage and the National Green Hydrogen Mission

This, in turn, strengthens the prospects of India in shaping the future of hydrogen as it overflows with abundant renewable resources. Capitalizing on the opportunity, the country launched the National Green Hydrogen Mission aimed at making India a leader in the production, usage, and export of green hydrogen. Where it focuses on accelerating the utilization of green hydrogen across the sectors, it is also determined to achieve production of 5 million metric tons of green hydrogen every year by 2030.

AWG Technology: Enabling Sustainable, Scalable, and Ethical Water Solutions for Green Hydrogen Production

Deploying air-to-water generator (AWG) technology empowers the electrolysis process by extracting water directly from the air. Other mechanisms, such as harvesting water through cooling by employing refrigeration cycle are not conducive for most of the time across the year. Therefore, AWG is a source of ethical water as it does not deprive the communities of water and generates it from moisture ubiquitously present in the air that preserves natural resources. In the process it promotes equitable access for communities and vouches for sustainable and net-zero principles.

The process of extracting water majorly depends on two factors, which involve humidity and temperature, where the moisture extracted from the air is cooled down to its dew point. This is an important step in initiating condensation of water vapour, which is later collected as water. The technology works best in high temperature and high humidity conditions; however, employing advanced adsorption technology helps in facilitating water extraction even in arid or semi-arid conditions. Making use of special adsorbents, it is adept at operating in relative humidity (RH) as low as 5-25%, prevalent in arid and semi-arid regions.

Gauging the benefits, AWG is considered an ideal solution that aims at producing water for electrolyser. Along with this, the technology is at the forefront of exhibiting eco-friendly practices, which further fortifies the entire purpose of introducing green hydrogen for marking the shift towards clean energy.

With India making significant strides in establishing its leadership in green hydrogen, it is the need of the hour that the country builds a resilient infrastructure with AWG technology. This will significantly contribute to scaling the production of green hydrogen at commercial level. Furthermore, considering that AWG does not require extensive infrastructure and being extracted at the site, it reduces the wastage of water due to transportation.

Conclusion: AWG's Strategic Importance in the Green Hydrogen Ecosystem

As a result, looking at the wide gamut of advantages AWG technology has to offer, it comes with a lot of potential to amplify the National Green Hydrogen Mission of the country. Providing pure white water, which is essential for performing the electrolysis, a crucial step in generating green hydrogen, it underscores the importance of AWG in the process. Therefore, while focusing on expediting the Green Hydrogen Mission of the country, it is mandatory to support it with AWG technology as well to ensure efficient production of green hydrogen.

We cater to both Business-to-Business (B2B) and Business-to-Consumer (B2C) audiences, ensuring a broad reach and relevance in our coverage.

SCHEDULE AN APPOINTMENT AND MEET THE TEAM

MACHINE EDGE GLOBAL

the IDEAL

SPACE FOR YOUR PRODUCT OR SERVICE

www.machineedgeglobal.com

+91 9766042062

Lightweight, High-Performance, and Aesthetic: ACPs as the Backbone of Modern Architecture

As India's urban landscape evolves at a breakneck pace, the architecture and construction industries are constantly seeking materials that deliver performance, efficiency, and aesthetic appeal. Among the many innovations driving this transformation, Aluminium Composite Panels (ACPs) have emerged as a game-changing solution. No longer confined to niche applications, ACPs are now a staple in modern architecture, balancing lightweight strength, fire safety, environmental durability, and design flexibility. This article explores how ACPs are redefining the building envelope and becoming the backbone of India's high-performance, future-ready infrastructure.

RAJESH SHAH,
MD, Euro Panel Products Limited.

Architects and builders are required to balance a range of standards, from structural integrity, thermal performance, and sustainability to aesthetic quality, and speedy construction. For a promptly urbanising country like India, with a rapidly rising skyline and the movement towards smart infrastructure, architects are experiencing a tectonic change in their approach to design. In the middle of this change, one material has steadily risen to the forefront, and is more than just a surface solution: the Aluminium Composite Panel (ACP).

Using ACP sheets like this has changed the architectural landscape and revolutionised construction in India through their lightweight, highly performing and flexible design. ACPs were once considered a thin product only suitable for construction in very specific industry segments, and have now become a prominent feature of architectural and construction projects in both rural and urban settings

Light, But Tough: The Engineering Advantage

One of the principal engineering features of ACPs is their incredibly high strength-to-weight ratio. Lightweight, at between 3.5 kg/m^2, less than stone, glass, and steel cladding, ACPs can china buildings by decreasing their overall dead load, ideally servicing every material girder structures currently being used for high-rise buildings – wherein higher-density living is developing in high-rise building cities like Mumbai, Hyderabad, and Bengaluru. If changing from stone cladding or a glass façade for a normal 20-storey building involved one percent dead load for the stone or glass, due to the nature and material of ACPs we could reduce their structural load a long over thirty percent - all of which translates to savings in foundation and reinforcement costs.

ACPs have huge accessibility advantages for transportation and easy handling on the site, along with easier install of cladding for fast-turnaround period budgets for fast growing tier II and III cities where cost equals time equals 0* and budgeting is phenomenal for corporations. They are also modular in design and so are beneficial to retrofit faster or better for façade renovation - which, in commercial cities of Gurugram, Pune, Chennai and so on - are very common, but less often for aesthetic reasons, often to apply regulations upon older buildings.

Fire Retardant and Safe for Future

Urban density is increasing in Indian cities - and with that, more fire-safety awareness public-wise and regulation-wise, with renewed interest from more recent fire tragedies arising from commercial buildings. Fortunately, the Indian ACP market has introduced large ranges of fire-retardant panels developed to excellent standards which provide, meet and exceed Indian standards and specifications equivalent to international frameworks. Fire retardant ACPs (or fire rated ACPs), like those meeting EN 13501 standards, are constructed with mineral-filled cores with smokeless and flame retardant properties. These versions are now commonplace in infrastructure projects like airports, hospitals, hotels, and malls. In fact, the new Terminal 2 of Kempegowda International Airport, Bengaluru uses FR ACP for its cladding and design, so beauty is built in with safety.

Durability to Face the Elements

From the coastal corrosion of Chennai to the dry heat of Jaipur

to the torrential rains of Kerala, India's built environment faces endless environmental duress. High-quality ACPs are built to take it all. With the surface coated with PVDF (polyvinylidene fluoride) or FEVE paint systems, ACP offers excellent resistance to UV rays, acid rain, dust and humidity. Most manufacturers offer 10-15 year warranties on their ACP sheets; however, the actual good looks often exceed this warranty. Panels look the same with colours and gloss even after ten years in the elements. They are impact and scratch resistant making them ideal for mixed public spaces or public transport infrastructure - for example, many metro stations, bus terminals and railway stations have had beauty upgrades with ACP cladding.

High Performance Through Advanced Manufacturing

The Indian ACP industry has matured technologically, and Continuous Coating Lines (CCLs),, and three-coat-two-bake processes are knowledgeable strengths of leading manufacturers. Leading Manufacturers of ACP have progressed into the field of precision engineering where they are able to provide predictable projects, adhesion strength, homogeneous thickness, and colour retention. Advanced manufacturing approaches not only abridge the mechanical properties of an individual ACP's flexural stiffness and peel strength, but also allow for an evolution of textures, finishes, and colours to be available to modern architects.

Conclusion

India's construction future has greater demands than simple aesthetic beauty, it will also demand that good-looking buildings develop into smart, safe, and sustainable structures, two overall functions of contemporary architecture that positions low rise or flat buildings into modern aspirations based on excellence or function. Aluminium Composite Panels have chipped into this role well due to their lightweight, durability, physical appearance, and sustainable quality. Not only are ACPs regardless of market segment of attractiveness accomplishing this market pull of character, innovation, and blue-sky thinking in a project delivery mode, but they are also changing building processes from classis 1A to emerging urban clusters. ACPs are enabling architects to redefine the envelope, builders to think delivery and spatial movement through design, and end users to provide comfort and function within the same enclosure — in all senses of the term an enveloping part of modern Indian architecture.

The Future of Floating: Digital, Green, and Deepwater Ready

JAAP-HARM WESTHUIS,
Technology, Innovation and Product Development Director, SBM Offshore

The offshore energy industry stands at the cusp of a new era—one defined by digital transformation, sustainability, and engineering innovation. As global energy needs evolve, Floating Production, Storage, and Offloading (FPSO) systems are rising to the challenge. No longer just vessels for hydrocarbon extraction, they are becoming smart, low-emission platforms designed for efficiency, safety, and resilience in increasingly complex environments. This article explores how cutting-edge technologies are shaping the future of floating production and redefining the offshore energy landscape.

The offshore energy sector has long been at the forefront of technological innovation, pushing engineering limits to meet the global energy demands. Floating Production, Storage, and Offloading (FPSO) vessels are essential for tapping deepwater and ultra-deepwater reserves and have evolved from just hydrocarbon extraction units into intelligent, low-emission platforms that support both energy security and sustainability goals.

A convergence of technological trends is driving this shift. From advanced digital tools and modular design to electrification and carbon capture, today's floating production systems are becoming smarter, leaner, and cleaner, ready to anchor the future of offshore energy.

Intelligent operations: Digitalization takes center stage

Digitalization has become central to how FPSO's are designed, built, and operated. Modern vessels are equipped with a suite of tools that enhance safety, uptime, and decision-making.

Digital twins simulate system behavior and environmental interactions in real time, helping operators test scenarios and improve responsiveness. AI and ML analyze vast sensor data to detect anomalies, predict failures, and optimize energy use, allowing to adjust operations to cut emissions and fuel consumption.

The ability to monitor and control FPSOs remotely is becoming increasingly important, driven by the need to improve safety, reduce costs, and enhance operational flexibility. Automation technologies, such as robotic systems, are also playing a growing role, performing tasks like inspections, maintenance, and repairs in hazardous or hard-to-access areas.

Decarbonization: Enabling low-emission operations

As the energy transition accelerates, FPSOs are not just keeping pace—they're evolving. A growing emphasis is being placed on decarbonization strategies that span design, construction, and operations. These efforts are anchored in four key areas:

- Energy efficiency is being enhanced through waste heat recovery, improved power generation, utilizing cold water from larger depths and advanced energy management systems
- Carbon capture, utilization, and storage (CCUS) solutions are being modularized and marinized to fit on FPSO topsides, capturing CO_2, for storage or reinjection, leveraging proximity to geological storage sites
- Alternative fuels such as hydrogen and ammonia are being explored, with pilot projects evaluating viability for future deployment
- Electrification is replacing gas turbines with electric drives and hybrid battery systems, significantly lowering operational emissions and flaring

Modularity and standardization: Efficiency at scale

Standardized and modular FPSO designs enhance efficiency, cost control, and deployment speed. Configurable topside modules and standardized hulls, support parallel fabrications and simplify upgrades like CCUS or electrification without major redesign.

This modular approach facilitates parallel fabrication, where topside modules and hulls are built simultaneously and integrated later. It also enables plug-and-play upgrades, allowing new technologies, such as carbon capture, use and storage (CCUS) or electrification systems, to be added without extensive redesign.

FPSOs with standard interfaces can also be more easily adapted and reused across different fields and stages of the energy cycle. This adaptability could help to mitigate economic risk and supports asset circularity, an increasingly important principle in sustainable infrastructure planning.

Engineering at the frontier: Deepwater and ultra-deepwater innovation

As offshore development pushes into deeper and more challenging waters, floating production systems must meet higher thresholds of technical and structural performance.

Subsea processing technologies are becoming more common, shifting key processing functions, such as separation and boosting, from the topside to the seabed. This reduces complexity, improves flow assurance, and minimizes environmental impact.

Advanced mooring systems ensure FPSOs remain firmly positioned in ultra-deepwater conditions. These systems are engineered to reduce maintenance needs while withstanding the dynamic forces of ocean currents and extreme weather.

Innovation is also extending to risers and flowlines, the physical links between subsea wells and the FPSO. Engineers are developing new materials and installation techniques to maintain integrity across longer distances and higher pressures.

Safety, reliability, and lifecycle performance

Safety remains a core pillar of offshore operations. Technology advancement is enabling more proactive safety management, from real-time structural monitoring to virtual training simulations that prepares the crew for high-risk scenarios.

The industry is also embracing lifecycle thinking, designing assets for adaptability and durability from the outset. Considerations extend beyond initial production to include ease of maintenance, mid-life upgrades, and eventual decommissioning or repurposing.

This holistic view ensures that floating production assets remain viable, safe, and cost-effective throughout their operating lives, while also minimizing their long-term environmental impact.

Collaboration: Accelerating innovation through partnership

The pace and complexity of innovation in floating production requires collaboration across the value chain. Industry partnerships, among developers, suppliers, academic institutions, and regulators, are playing a vital role in fast-tracking new technologies and aligning standards for safety and sustainability.

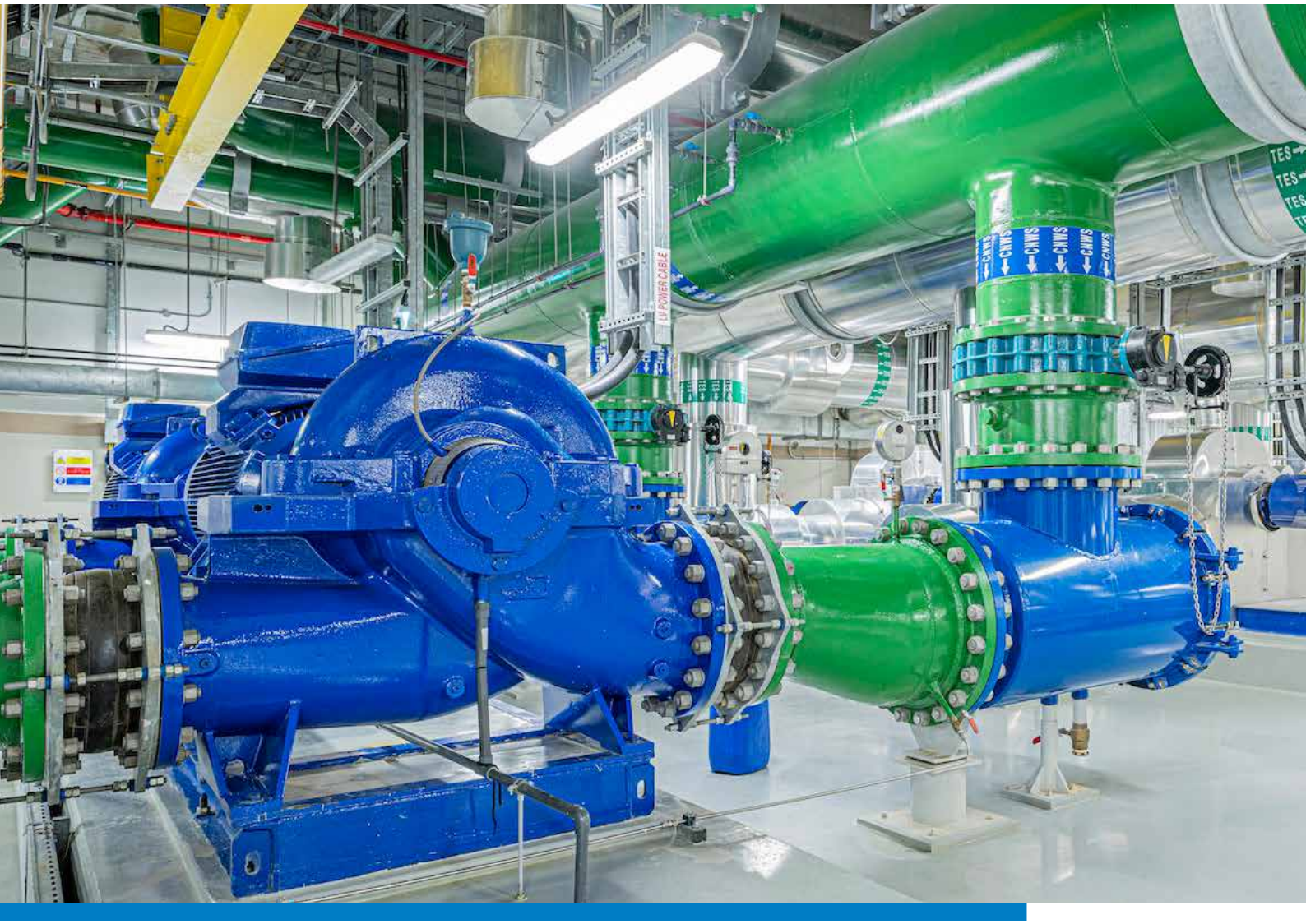
Equally important is talent development. The future of offshore energy depends on talent skilled in data analytics, digital operations, renewable, and environmental compliance. Investing in upskilling and attracting the next generation of professionals is essential for long-term success.

Redefining offshore energy for a new era

The offshore sector is undergoing a major transformation, where evolving challenges demand smarter, more sustainable solutions. Floating production systems are becoming digital, modular, and low-carbon infrastructure supporting a responsible energy transition. These intelligent assets are built to adapt to a rapidly changing energy landscape.

From seabed to surface, emerging technologies are enabling faster deployment, lower emissions, and safer operations. These innovations are not only improving project economics, but they're cementing offshore energy's role in a more sustainable global future.

As digitalization, decarbonization, and deepwater innovation converge, floating production is unlocking new resources and powering progress toward a cleaner, more resilient energy system.



How Sustainable Cooling Can Redefine Urban Climate Action

SUDHEER PERLA,
Managing Director,
Tabreed Asia

As cities grapple with rising temperatures and increasing cooling demands, traditional air conditioning systems risk intensifying climate challenges and urban heat stress. This article explores how sustainable cooling solutions, particularly District Cooling, offer a transformative approach to urban climate action—reducing greenhouse gas emissions, easing energy loads, and building more resilient, livable cities for a warming world.

As the world rapidly urbanizes and global temperatures rise, cities are emerging as both the victims and contributors to climate change. Central to this crisis is the release of greenhouse gases (GHGs), primarily on account of human-induced activities, which trap heat in the atmosphere and drive global warming.

The Rising Toll of Cooling

Compounding the issue is the surging demand for cooling, driven by intensifying heatwaves that are becoming more frequent and severe due to climate change. India's cooling sector is projected to grow eightfold by 2038, with air conditioning penetration rising from 8% to 40%. The expected cooling demand, driven primarily by urban and industrial clusters, could drive energy consumption to 45% of peak power load by 2050, pushing GHG emissions to 90% above 2017 levels.

The consequences of unchecked GHG emissions are increasingly being felt in cities, where the Urban Heat Island (UHI) effect exacerbates the impacts of climate change. Declining tree cover and dense urban materials like concrete and glass facades which absorb and retain heat, are raising temperatures in cities by up to 4°C compared to surrounding rural areas, perpetuating feedback loops for heightened heat stress, further increasing cooling demand. This intensifies health risks, strains energy grids and disproportionately affects vulnerable populations, including the elderly and low-income residents.

While CO_2 is the most prevalent greenhouse gas, emissions from refrigerant leaks, often underestimated, are a major source of GHG emissions, particularly due to the high global warming potential (GWP) of hydrofluorocarbons (HFCs), which are commonly used in air conditioning systems. When these systems leak – either during use, servicing or at end-of-life – HFCs escape into the atmosphere, where they can be thousands of times more potent than CO_2 in trapping heat. Global refrigerant emissions equal approximately 2,000 million tons of CO2 annually is equivalent to the entire global aviation industry.

Urban life is thus at a critical juncture. As cities struggle to keep cool, conventional cooling methods, such as split/window air-conditioners or stand-alone systems, threaten to deepen the climate crisis. It is essential to view cooling as a vital service, necessary for survival, that must be made to reduce its material and climate footprint. Sustainable cooling solutions such as District Cooling offer a path forward—one that can protect both people and the planet from the cascading effects of a warming world.

District Cooling: A Scalable, Sustainable Solution

District Cooling systems aggregate cooling demand centrally to meet it through a centralised plant that produces chilled water and delivers it to multiple buildings within a defined area through an insulated pipeline network.

By leveraging diversified demand profiles – where commercial buildings peak during the day and residential buildings at night – District Cooling can cut installed mechanical capacity by up to 50%, thus reducing the physical infrastructure required. The result is optimized system sizing, reduced capital costs and a significant drop in both upstream and downstream GHG emissions. In addition, by employing energy-efficient, industrial-grade equipment alongside advanced operations and maintenance practices, District Cooling optimizes energy consumption. Crucially, District Cooling helps mitigate urban heat islands. Unlike conventional air conditioners that reject heat directly into the air, DC systems dissipate heat in treated water or natural water bodies such as rivers and lakes, breaking the local micro-climate feedback loops that increase cooling demand.

Refrigerant Management: The Invisible Climate Lever

Reducing refrigerant emissions is another critical pathway to climate-safe cooling. While the transition to low-GWP refrigerants is slow for the traditional split/window AC systems, District Cooling systems due to their sheer scale and size can fast-track use of refrigerants with lower GWP and Zero Ozone Depletion Potential (ODP), which would otherwise not be as commercially viable.

Tabreed in India, for instance, has begun transitioning its chillers to use hydrofluoroolefins (HFOs) with a GWP less than 1. Additionally, it deploys Refrigerant Leak Detection Systems (RLDS) and Refrigerant Recovery Units (RRUs) to prevent and mitigate leaks. These practices exceed current standards in the cooling industry and are essential for meeting global climate commitments, such as those outlined in the Kigali

Amendment to the Montreal Protocol, which India ratified in 2021.

Building Resilience through Decarbonised Cooling

One of India's most ambitious District Cooling deployments is in Amaravati, Andhra Pradesh's planned greenfield capital. The city's master plan includes a target of 51% green cover to reduce ambient temperatures by up to 3°C and energy-efficient designs to cut power demand by 30%. One of the first initiatives is at the Amaravati Government Complex (AGC), where a 20,000 RT District Cooling system is being developed by Tabreed under a 32-year public-private partnership (PPP). The system is expected to deliver a 25% reduction in installed cooling capacity, a 50% cut in power demand, 40 million kWh in annual energy savings and zero refrigerant leakage.

Recognising the value of the upcoming system, Amaravati has indicated that city-wide cooling provisions will also be met through District Cooling systems, setting it up as not only the first in India but potentially the first in Asia to explore widespread District Cooling implementation across all high-density development zones in its masterplan. Once implemented, this approach could unlock 2.2 million RT of cooling potential and reduce power demand by 1.8 GW, positioning Amaravati as a pioneering model for energy-efficient urban planning.

Another landmark initiative is planned at Hyderabad Pharma City (HPC), the world's largest bulk drug manufacturing hub. Developed by the Government of Telangana in the outskirts of Hyderabad, HPC aims to decongest the city and mitigate its UHI effect along with balancing economic growth with environmental responsibility. The master plan envisions five interconnected District Cooling plants of 25,000 RT each, totalling 125,000 RT, making it Asia's largest PPP-based cooling concession. The $400 million project, awarded to Tabreed, is expected to achieve 35% lower mechanical load, 50% savings in power demand compared to stand-alone systems, and170 GWh (~25%) reduction in energy use and associated GHG emissions. By planning cooling infrastructure alongside industrial expansion, HPC is redefining how energy-intensive developments can contribute to climate mitigation.

Conclusion

Cooling is not a luxury – it is a necessity in our warming world. However, unless addressed with foresight and innovation, the cooling sector could become one of the largest drivers of GHG emissions and urban heat stress. District Cooling provides a scalable, energy-efficient and climate-resilient alternative to conventional air-conditioning, which through strategic infrastructure planning, public-private partnerships and cutting-edge refrigerant management can redefine the urban landscape. As cities continue to grow, embracing such solutions is an essential climate action that will pave the way for equitable and resilient cities without heating our planet.

Robotics in Metal Cutting: The Rise of Fully Automated Fabrication Lines

The metal cutting industry is witnessing a transformative shift as robotics and automation redefine traditional fabrication processes. Driven by the need for greater precision, efficiency, and scalability, fully automated fabrication lines are setting new standards in metalworking. This article explores how the fusion of advanced cutting technologies with robotic systems is revolutionizing metal fabrication, boosting productivity, enhancing safety, and paving the way for the future of smart manufacturing.

YUVRAJ SHIDHAYE
Founder and Director,
TreadBinary

Metal cutting has long been the foundation of modern manufacturing, demanding precision, quality, and consistency. Now, with industries racing to meet tighter deadlines and higher quality standards, the sector is undergoing a fundamental shift. Conventional machining tools are giving way to a new era of automation powered by robotics, Artificial Intelligence (AI), and advanced cutting technologies.

This transformation is further underscored by the rapid growth of the metal fabrication market, which was valued at USD 82.09 billion in 2024 and is projected to reach USD 108.18 billion by 2033, growing at a compound annual growth rate (CAGR) of 3.1% from 2025 to 2033. As automation takes centre stage, manufacturers are not only optimizing workflows but also redefining traditional metal-cutting methodologies, paving the way for the next generation of fabrication technologies.

Evolution of Metal Cutting Technologies

Advanced metal cutting methodologies like laser cutting, plasma cutting, waterjet cutting, and oxyfuel cutting are bringing unparalleled precision, efficiency, and scalability to fabrication processes. Laser cutting, for example, employs a high-energy beam for non-contact material separation, which requires extreme precision. Similarly, plasma cutting utilises accelerated ionised gas to slice through conductive metals, while waterjet cutting, often combined with abrasives, ensures clean and precise cuts across various materials. The integration of robots with these cutting-edge methods can further amplify their effectiveness.

Impact of Blending Modern Cutting Tools with Robotics

The integration of robotics into metal cutting is driving a paradigm shift in fabrication lines. As industries transition towards smarter production, robotic cutting systems are reshaping workflows, setting new benchmarks for efficiency and accuracy in modern fabrication.

Extreme Precision and Accuracy

Robotic systems deliver a level of accuracy that far surpasses traditional methods. Unlike manual processes prone to inconsistencies, these automated systems execute each cut with extreme precision, ensuring uniformity across production. This heightened accuracy enhances product quality while minimising material wastage, leading to optimised resource utilisation and improved operational efficiency.

Robotic cutters excel at consistently replicating intricate designs and complex patterns, making them superior to conventional cutting methods. When combined with cutting-edge techniques like laser and waterjet cutting, robots ensure unparalleled consistency and detail in metal fabrication.

Boosting Productivity Through Automation

The impact of robotics on productivity extends far beyond speed enhancements. Conventional metal-cutting methods often depend on extensive manual intervention, resulting in variability and slower turnaround times.

Automated fabrication lines, in contrast, facilitate seamless and uninterrupted workflows, dramatically increasing throughput. By refining material handling and maintaining continuous operations, these systems eliminate inefficiencies, reduce downtime, and substantially boost productivity without compromising on quality.

Lowering Costs and Strengthening Workplace Safety

Beyond efficiency gains, robotic automation in metal cutting delivers substantial cost savings and improved workplace safety. These advanced systems are engineered to handle hazardous tasks, heavy materials, and intricate cutting processes with exceptional precision, reducing the risk of workplace injuries.

By minimising human exposure to dangerous environments, manufacturers not only improve safety but also cut costs associated with accident-related disruptions.

Adaptability and Scalability in Manufacturing

Automated fabrication lines offer remarkable adaptability and scalability, enabling manufacturers to adjust processes with ease. These systems can be programmed to manage diverse cutting techniques, from simple sheet metal trimming to intricate three-dimensional designs. Their versatility makes them indispensable across a broad spectrum of industries, including automotive, aerospace, construction, and shipbuilding, where precision and efficiency are paramount.

The Future of Robotics in Manufacturing

As automation advances, robotic metal cutting is emerging as a cornerstone of Industry 4.0, seamlessly integrating with smart factories powered by AI and IoT. These innovations enable real-time monitoring, adaptive adjustments, and optimized coordination between robotic cutting systems and broader production networks. This evolution is redefining industrial standards, making robotics indispensable in modern manufacturing. Furthermore, collaborative robots (cobots) designed to work alongside human operators enhance both flexibility and precision. By merging robotics with cutting-edge metal fabrication technologies, manufacturers can not only achieve superior accuracy and efficiency but also unlock new levels of adaptability, setting the stage for the next generation of intelligent production systems.

Conclusion

The dominance of robotics in metal cutting is no longer a distant vision; it is the present and future of industrial fabrication. As manufacturing embraces data-driven intelligence, automation is becoming the linchpin of precision, efficiency, and scalability. The industries that swiftly integrate these cutting-edge solutions will not just stay competitive but will redefine production standards, fostering both innovation and sustainability. The shift towards fully automated fabrication is not merely an enhancement; it is a transformative leap into the next era of manufacturing excellence.

Name	Page
Avener Capital	16
Bosch Global Software Technologies (BGSW	10
Bry-Air	36
DZONE Technologies	Back Inside
Euro Panel Products Limited	15, 40
Event Brigade	35
Phillips Machine Tools India Pvt Ltd	Back Cover
SBM Offshore	44
Schmalz India Pvt Ltd	Front Inside
Tabreed Asia	48
TreadBinary	52
Volvo Construction Equipment India	04

IMPRINT

Founder

Sanjay Jadhav
editor@machineedgeglobal.com
Contact: +91 97660 42062

Design and Layout

Nexus Media
nexus.media61@gmail.com

Editorial & Business Office

Machine Edge Global
C 708, Aishwaryam Courtyard,
Opp Newale Vasti,
Akurdi Chikhali Road,
Near Sane Chowk.
Pune - 411062
Maharashtra, India
Tel: +91 97660 42062

www.machineedgeglobal.com

DZONE TECHNOLOGIES	**Projects Executed >** All terrain | All Surfaces | 14,14,500 km | 45°C to -5°C | Since 2012
RIDERS DRIVERS	Experts and well experienced in field trial projects. They are trained to be alert and observant of symptoms or outcomes. This includes daily and periodic data handling as required.
SUBJECTIVE FEEDBACKS	The Team of riders / drivers are well trained to give near accurate feedbacks.
ENDURANCE TEST	Our team has executed more than **14 lakh km** of endurance projects in harsh terrain and weather (45°C to -5°C), across India and all in record time.
DATA ACQUISITION	**Real Time Logging>** Fuel Consumption | TPMS with Tyre Temperature | Speed | Distance | Location (GPS) | Braking Distance | Acceleration Time | Temperature - Engine Oil, Engine Surface, Ambient | **Electric Vehicle>** Battery (Voltage, Current, Temperature), Mileage, and more parameters as needed. **Periodical Logging >** Tread depth measurement and tyre surface condition
PROCEDURE	Strictly as per the guidelines of the project initiator

DZONE TECHNOLOGIES

A-13 S, 32/6, Aamrai, Near Zeal College, Narhe, Tal - Haveli, Pune 411041
+91-9860116255 | Email: contact@dzoneworld.com | www.dzoneworld.com

Phillips
MACHINE TOOLS

REVOLUTIONIZE DEFENCE MANUFACTURING WITH **PHILLIPS AEROSPACE & DEFENCE WING!**

BOMB SHELL

BARREL

TURRET

HULL

WEAPONS

Contact Us Today to Learn More!

Phillips Machine Tools India Pvt. Ltd.

support.india@phillipscorp.com +91 7410003380 www.phillipscorp.com

Experience Manufacturing Innovation

www.PhillipsCorp.com