



Navigating the Cutting Edge of Industry News

EVENT REPORT

Avener Capital

MARKET AND STRATEGY

Vijayan Trishul Defence Solutions (VTDS)

PRODUCT UPDATE

ELGi

VOICES OF INDUSTRY

True Colors Limited

In The Hot Seat

**SANDRO
BOTTAZZO
CEO, STUDER**





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



India's Manufacturing Momentum: Powered by Growth, Driven by Innovation

India is on the brink of a historic achievement—set to overtake Japan in 2025 and become the world's third-largest economy. According to the IMF's April 2025 World Economic Outlook, India's GDP is expected to touch \$4.187 trillion, just ahead of Japan's \$4.186 trillion.

This milestone is energising the manufacturing sector, which is projected to reach ₹87,57,000 crore (US\$1 trillion) by FY26, led by Gujarat, Maharashtra, and Tamil Nadu, with robust growth in automobiles, electronics, and textiles.

Government initiatives such as Make in India and the PLI schemes continue to attract foreign investments, strengthen industrial infrastructure, and promote a self-reliant manufacturing ecosystem. Since its launch in 2014, Make in India has transformed industries, created employment, and repositioned India on the global map—powered by the relentless dedication of its workforce.

In this issue, our cover story features Sandro Bottazzo, CEO of STUDER, sharing insights on navigating global manufacturing challenges and leading advancements in automation, AI, and sustainable grinding technologies. We also speak with Sahil Luthra, Founder & MD of Vijayan Trishul Defence Solutions, on the company's innovation-driven approach to developing indigenous defence technologies that bolster both national and global security.

Other highlights include an industry report on Battery Energy Storage Systems, an analysis of the mobility toy market's developmental potential, an exploration of IoT- and AI-enabled biofuel storage solutions, and a feature on how digital textile printing is reshaping the industry with cleaner, faster, and more flexible processes.

At Machine Edge Global, we remain committed to spotlighting the innovations, strategies, and people shaping the future of industry.

Sanjay Jadhav

Sanjay Jadhav

Founder & Editor

editor@machineedgeglobal.com

CONTENTS

IN THE HOT SEAT

Sandro Bottazzo, CEO, STUDER

04

An Exclusive interview with Sandro Bottazzo, sharing a clear vision for STUDER's role in shaping the future of high-precision cylindrical grinding.

MARKET AND STRATEGY

Sahil Luthra, Founder & Managing Director, VTDS

10

In this interview Mr Luthra speaks about the company's origin, innovation-led approach, and commitment to building indigenous defence technologies that support both national and global security goals.

INDUSTRY REPORT

BATTERY ENERGY STORAGE SYSTEM

16

A research report on Battery Energy Storage System by AVENER Capital.

PRODUCT UPDATE

ELGi's PG Series Electric Portable Screw Compressors 32

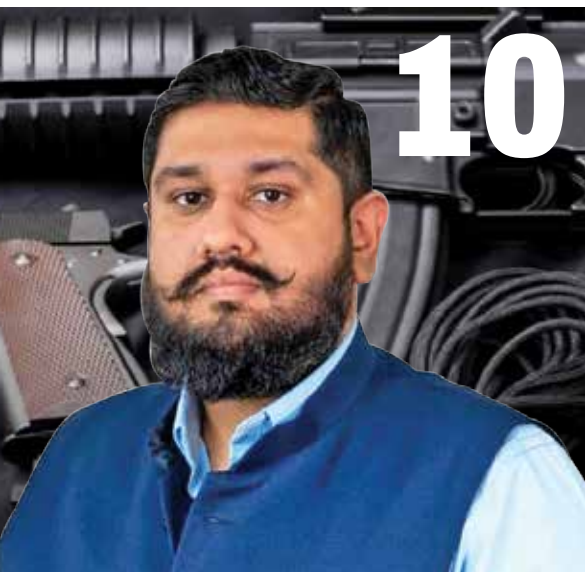
ELGi's PG Series Electric Portable Screw Compressors are engineered to deliver high performance while setting a new benchmark in eco-friendly, portable compressed air solutions.



50



36



VOICES OF INDUSTRY

Designing Childhood: The Power of Mobility Toys 36

This article emphasise the safety, age-appropriate design, and developmental benefits of mobility toys that can transform this market and unlock greater impact for both children and the industry.

Smart Tech for Smarter Biofuel Storage 42

This article stresses that biofuel are a crucial part of the clean energy transition, but their storage and distribution pose unique challenges.

Is Lithium Still the Key to the Future of Mobility? 46

This article asks if will lithium continue to drive the future of mobility, or is its time limited?

Why Digital Textile Printing is Key to Greener Manufacturing? 50

As global textile hubs embrace this shift, digital printing is proving to be a sustainable and economically viable game-changer for the entire value chain.

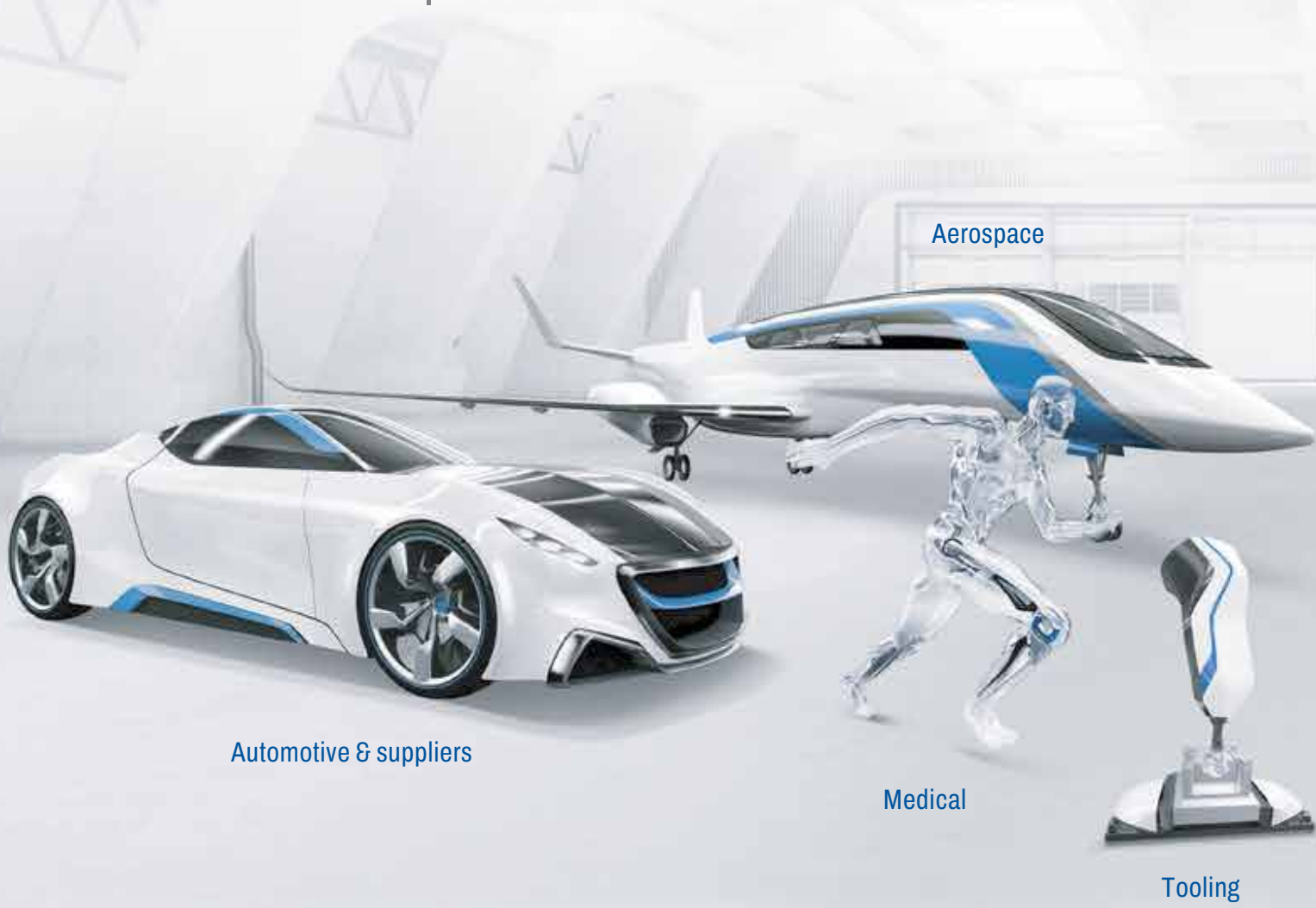
Company Index/Imprint 54





“Despite the current economic situation, there remains strong interest in technological innovation - particularly in the field of high-precision grinding”

In this exclusive conversation with Machine Edge Global, **Sandro Bottazzo, CEO, STUDER**; shares valuable insights on navigating today’s complex global manufacturing landscape. From strategic growth amid evolving trade dynamics to pioneering advancements in automation, AI, and sustainable grinding technologies, Mr. Bottazzo offers a clear vision for STUDER’s role in shaping the future of high-precision cylindrical grinding. Join us as we explore how STUDER continues to innovate and support its global customers in an increasingly interconnected and challenging market environment.



Automotive & suppliers

Aerospace

Medical

Tooling

Q. As the new CEO of STUDER, how do you envision recalibrating the company’s strategic roadmap to sustain growth amidst rising global protectionism and post-pandemic supply chain realignments?

▶▶ At STUDER, our mission remains clear, which is to make our customers even more successful and competitive. This principle guides the development of our high-precision external and internal cylindrical grinding machines, as well as the services we provide.

We continue to take a long-term,

customer-centric approach in shaping our strategy which is closely aligning with the needs of our target industries. This has enabled us to build a strong global presence, supported by our own teams and trusted sales partners, ensuring we stay close to our customers both in sales and aftercare.

Thanks to consistent supply chain management, we have been able to uphold our delivery performance even in challenging times. This reliability is what allows us to offer some of the shortest delivery times in the market.

Q. With the potential reimplementation or escalation of Trump-era tariff policies targeting

industrial and machine tools, how do you foresee these developments shaping STUDER’s global sales outlook for FY 2025–2026—particularly in key regions like North America and Asia? What strategic measures are you considering to mitigate cost volatility and preserve competitiveness amidst evolving trade barriers?

▶▶ Thanks to our decentralised organisational structure, we are well positioned to navigate evolving trade dynamics and stay close to our key markets. For instance, in North

Transport & heavy industry

Energy



Machine manufacturers

Die & Mold

Precision Engineering

America, our competence center in Miamisburg (Ohio), focuses on customer-specific solutions, while in Shanghai (China), we maintain local production capabilities tailored to the regional market.

This setup not only enables us to respond quickly to local customer needs but also helps us manage external uncertainties such as tariff fluctuations or trade policy shifts. By maintaining a strong local presence, we can better absorb cost volatility, reduce dependencies, and continue offering high-value solutions with reliable support. This proximity to our customers is a critical component of our strategy for sustaining competitiveness across diverse markets, including North America and Asia, in the years ahead.

Q. STUDER's advancements in automation and smart CNC platforms position it at the forefront of Industry 4.0. How do you see AI and adaptive learning systems reshaping grinding machine intelligence over the next 5 years?

▶ The use of artificial intelligence will develop out of digitalization. This is because AI can further optimize processes based on the large amount of data collected, comprehensive data analysis, and the insights automatically derived from this.

Machine learning could help

to develop processes according to selectable criteria, such as energy efficiency.

AI could be seen as a support for process planners, designers, developers, programmers, operators, and service personnel. We see potential for it to support us as manufacturers and production companies in administrative and operational areas, helping us to work more sustainably.

Q. The European economy continues to face significant headwinds, with persistent inflationary pressures and industrial slowdowns. How do you assess this



environment in terms of its impact on STUDER's operations and business outlook? Additionally, are workforce reductions or organisational restructuring part of your contingency planning in response to these macroeconomic conditions?

▶ Our broad customer and market diversification is a key strength, especially in times of economic uncertainty. It allows us to maintain stable capacity utilisation, even when specific regions or sectors experience slowdowns.

In fact, despite the current headwinds in parts of the European economy, we are seeing increasing demand for high-precision external and internal cylindrical grinding machines in several markets and industries.

Q. With new product launches planned for EMO, how do you evaluate market receptiveness in the current recessionary climate? Do you anticipate a cautious investment sentiment from customers, or is there still robust demand for high-precision innovations in grinding technology?

▶ Despite the current economic situation, there remains strong interest in technological innovation - particularly in the field of high-precision grinding. While many companies are approaching investments with greater caution, they are actively seeking solutions that enhance efficiency, enable automation, and reduce long-term operating costs. Innovations that

deliver tangible value under these criteria are attracting attention, even in a more restrained market environment.

In the lead-up to EMO, it's becoming clear that investment decisions are more selective, but not suspended. As such, the trade fair is set to be an important driver for forward-thinking investment - especially in times of economic uncertainty.

Q. Do you envision technologies like WireDress® or SmartJet™ becoming new industry standards, and what kind of patent or licensing strategies are you deploying to maintain innovation leadership?

▶ For STUDER, technologies like WireDress®, SmartJet™, and C.O.R.E.



are löschen of central importance, as they contribute significantly to our process's efficiency, precision and innovative strength. SmartJet™ technology efficiently controls cooling and energy consumption, reducing coolant consumption by up to 40% and energy consumption by up to 50%. This resource-saving solution is ideal for companies that want to combine sustainability and cost efficiency.

WireDress® technology enables metal-bonded CBN and diamond grinding wheels to be dressed directly in the machine, leading to up to 30% higher grinding performance. It also significantly extends the service life grinding wheels, minimising downtime and boosting productivity.

C.O.R.E. technology simplifies machine operation with digital assistance systems. Functions such as Remote Service enable quick troubleshooting, while the Service

and Production Monitor keep an eye on maintenance work and production processes in real-time. These smart solutions increase efficiency and ensure smooth operation. With C.O.R.E. technology, machine operation is also simplified by digital assistance systems. Functions such as Remote Service enable quick troubleshooting. In addition, the large multi-touch display enables intuitive operation, just like on a smartphone. Furthermore, the UNITED GRINDING Digital Solutions™ digital assistance system can be accessed directly on the machine.

Q. The global civil aviation industry is on a strong growth trajectory. How is STUDER aligning its innovation roadmap with the expanding


needs of OEMs and Tier-1 suppliers in aerospace?

▶▶ The strong growth in the civil aviation sector calls for even greater precision, reliability, and efficiency. At STUDER, we align our innovation roadmap closely with these evolving demands. Our grinding solutions are specifically designed to meet the strict standards of OEMs and Tier-1 suppliers, particularly in critical areas like turbine component machining.

Through smart monitoring, adaptive control, and scalable automation, we help our aerospace partners enhance productivity while preparing for the next generation of aircraft manufacturing. This ongoing collaboration ensures our technologies remain at the forefront of aerospace production requirements.

Q. How do you envision the convergence of digitalization, automation, and sustainability shaping the future of high-precision grinding? Is STUDER investing in any cross-functional platforms to lead this convergence?

▶▶ We view the convergence of digitalisation, automation, and sustainability as a key driver shaping the future of high-precision grinding. These elements are closely linked, forming an integrated approach that enhances performance, efficiency, and delivers lasting value.

At STUDER, we are investing in cross-functional platforms that bring together smart process control, energy-efficient machine design, and data-driven service models. This integrated approach enables us to lead in innovation while supporting our customers' goals for productivity and sustainability. 



“Our goal is to help position India not just as a consumer, but as a strategic contributor in the evolving global defence landscape”

As India accelerates its push for defence self-reliance, homegrown companies like **Vijayan Trishul Defence Solutions (VTDS)** are playing a vital role in reshaping the nation’s security ecosystem. In this exclusive interview, **Sahil Luthra, Founder & Managing Director, VTDS**, speaks with Machine Edge Global about the company’s origin, innovation-led approach, and commitment to building indigenous defence technologies that support both national and global security goals.





Q. **Vijayan Trishul Defence Solutions has carved a niche in India's growing defence manufacturing sector. What was the founding vision behind the company, and how has it evolved over the years?**

▶▶ Vijayan Trishul Defence Solutions (VTDS) was established with a clear purpose: to build indigenous capabilities in India's critical defence technology ecosystem, particularly in the arms and ammunition domain. Rooted in the vision of self-reliance, our goal has always been to contribute meaningfully to national security through homegrown innovation. Since inception, VTDS has adopted an R&D-led approach to develop future-forward solutions that address the evolving needs of the Indian armed forces. Our journey continues with a

focus on intelligent design, modular engineering, and scalable prototyping, all aligned to power the next generation of Indian defence systems.

Q. **What sets VTDS apart from other defence solution providers in terms of indigenous innovation, R&D capabilities, and strategic partnerships?**

▶▶ VTDS stands apart through its unwavering commitment to indigenous development and a forward-thinking approach to defence technology. Our agile R&D framework enables rapid experimentation and refinement, ensuring we respond swiftly to operational requirements. From inception, we've maintained a systems-first mindset, integrating modularity and automation into our design philosophy. What truly differentiates us

is a seamless, purpose-built ecosystem where engineering, compliance, and innovation work in sync, ensuring every solution we conceptualise is aligned with the demanding standards of defence-readiness.

Q. **Can you walk us through some of your flagship technologies or products that are currently being deployed by defence or paramilitary forces?**

▶▶ We are currently advancing a range of high-impact solutions with a strong emphasis on precision, reliability, and operational adaptability. VTDS is developing systems aligned with the tactical requirements of India's defence forces, combining deep research with iterative prototyping. While still in the pre-deployment phase, our focus remains on creating robust, scalable



platforms that strengthen tactical preparedness and reduce dependency on external systems. Every project under development is guided by our mission to deliver indigenous value where it matters most, on the ground, in real time.

Q. With the rising demand for AI, automation, and unmanned solutions in modern warfare, how is VTDS integrating next-gen technologies into its product offerings?

▶▶ We recognise that the future of modern combat lies at the intersection of firepower and intelligent systems. As we expand our capabilities in the arms and ammunition segment, we are embedding next-generation technologies, including AI-driven

analytics, automated operations, and smart interfaces, into our core R&D pipeline. These innovations are aimed at enhancing precision, efficiency, and responsiveness, ensuring our solutions are not only robust, but also adaptive to the ever-changing dynamics of the battlefield.

Q. How is Vijayan Trishul Defence Solutions contributing to the 'Atmanirbhar Bharat' initiative in the defence sector, and are there any plans for exports or global collaborations?

▶▶ VTDS is deeply committed to the vision of Atmanirbhar Bharat, with self-reliance forming the backbone of our philosophy. Our aim is to develop indigenous capabilities that directly cater to India's defence needs,

particularly in arms and ammunition, while systematically reducing reliance on imported technologies. Alongside our national focus, we are also preparing for responsible global collaborations and long-term export potential. Our goal is to help position India not just as a consumer, but as a strategic contributor in the evolving global defence landscape.

Q. As a growing defence tech company, how do you approach talent development, skilling, and retaining top minds in such a critical industry? What does the future roadmap for VTDS look like in the next 5 years?

▶▶ At VTDS, we believe that building national defence capability begins with nurturing exceptional talent. We

actively engage with leading technical institutions and experienced defence professionals to cultivate a workforce that combines deep technical insight with mission-driven passion. Our structured skilling initiatives ensure continuous learning, domain expertise, and alignment with sectoral evolution.

Looking ahead, our strategic roadmap includes:

- Transitioning high-potential prototypes into deployment-ready platforms
- Establishing advanced testing and simulation facilities for in-house validation
- Building strong public-private collaborations, both domestically and internationally, to accelerate innovation and operational excellence.



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



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

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



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

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

Battery Energy Storage System

Sustaining India's Energy Goals

Industry Report

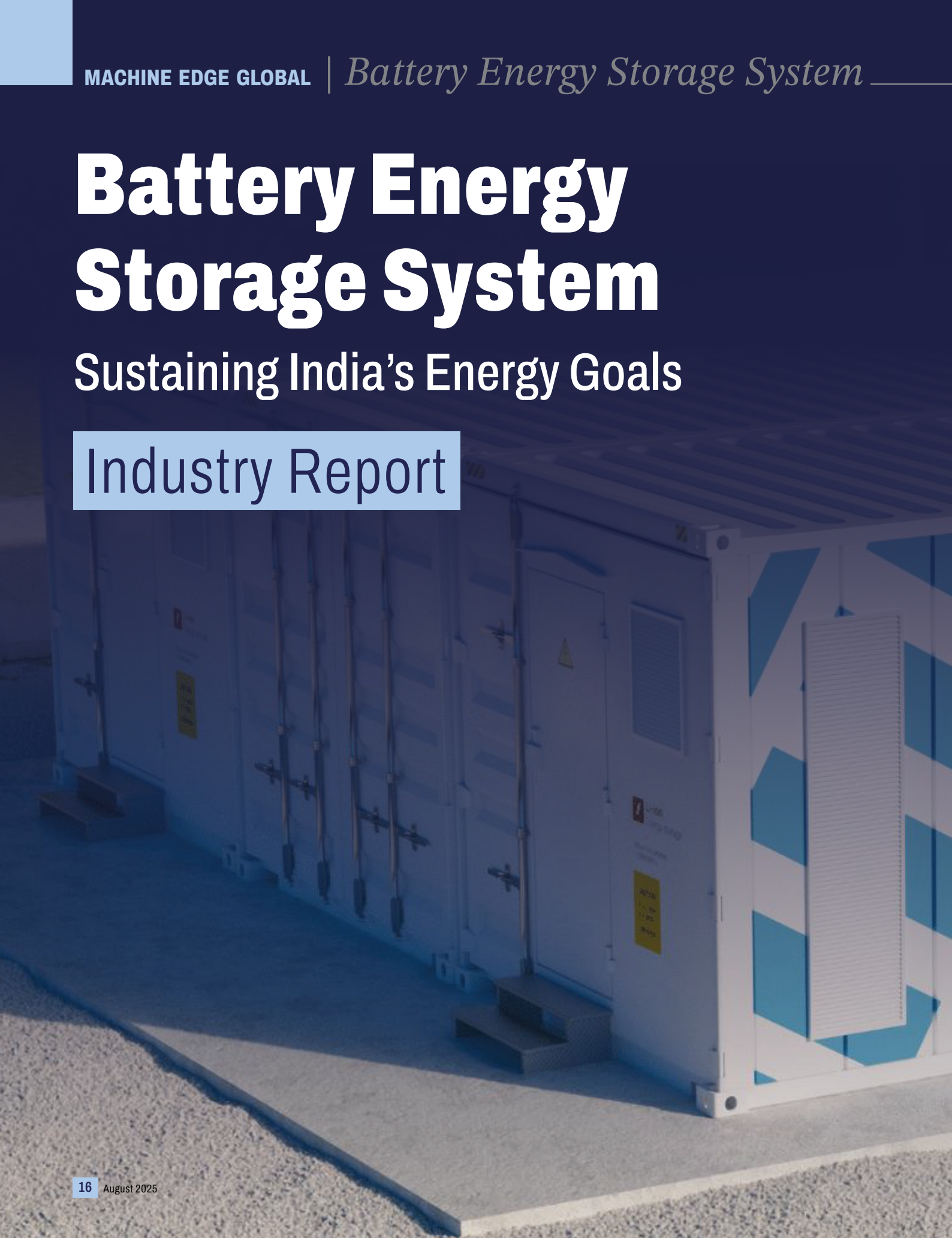


TABLE OF CONTENTS

The India Opportunity	3
Operating Mechanics.....	8
Risk & Return Dynamics	13
Market Mapping.....	16
Capitalising on the Opportunity	27
Avener Capital About Us	29



ENERGY
STORAGE

The India Opportunity



Battery Energy Storage System

BESS to expand to 66 GW capacity from <0.2 GW

BESS in India on the Cusp of Significant Growth



India's Goals & Schemes supporting BESS Growth

4% Energy Storage Obligations by 2030 from 1% in 2024

PLI ~5 GWh for battery manufacturing

Net Zero by 2070

Source: CEA, NEP, Avenir Estimates

7x

Growth

₹ 5 Lakh Cr

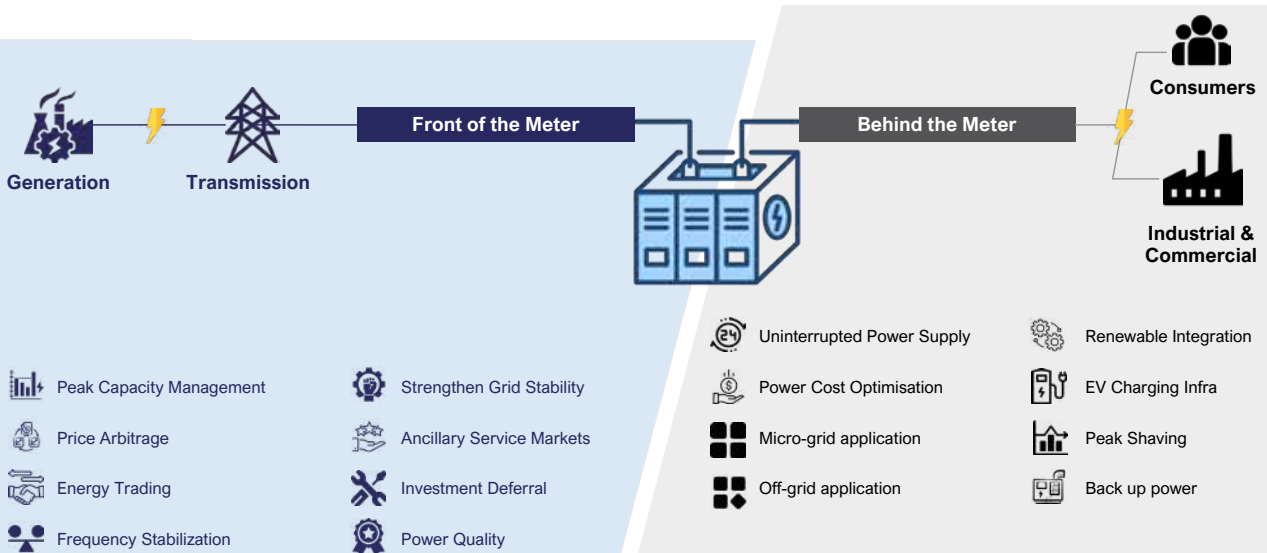
Opportunity

2,000+ MT

Avoided CO₂ emissions

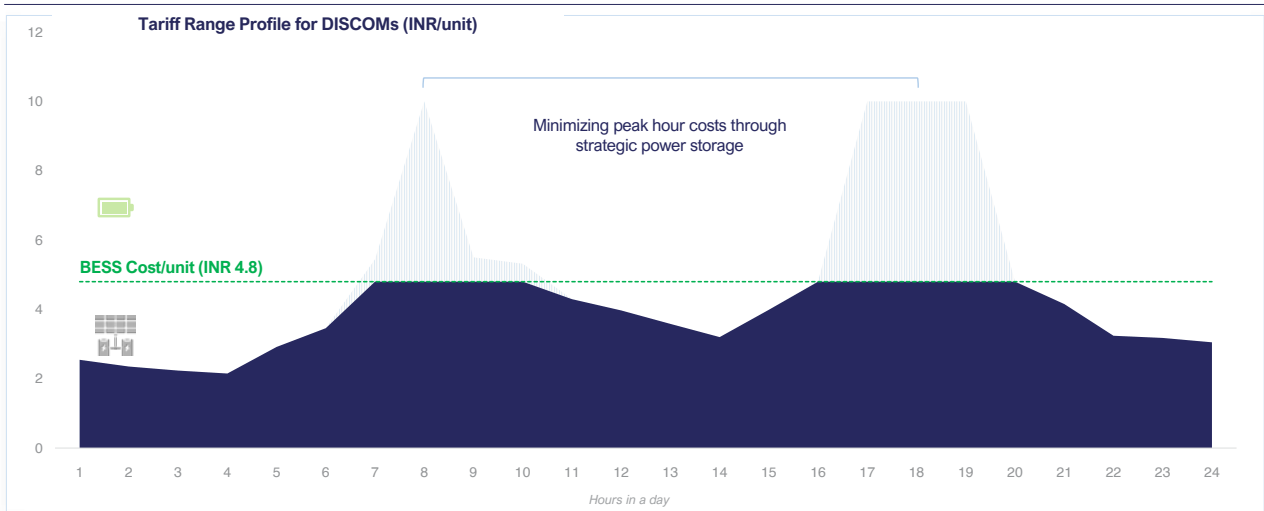
Value Chain

BESS' utility is present across the value chain



Optimizing Energy Costs with BESS

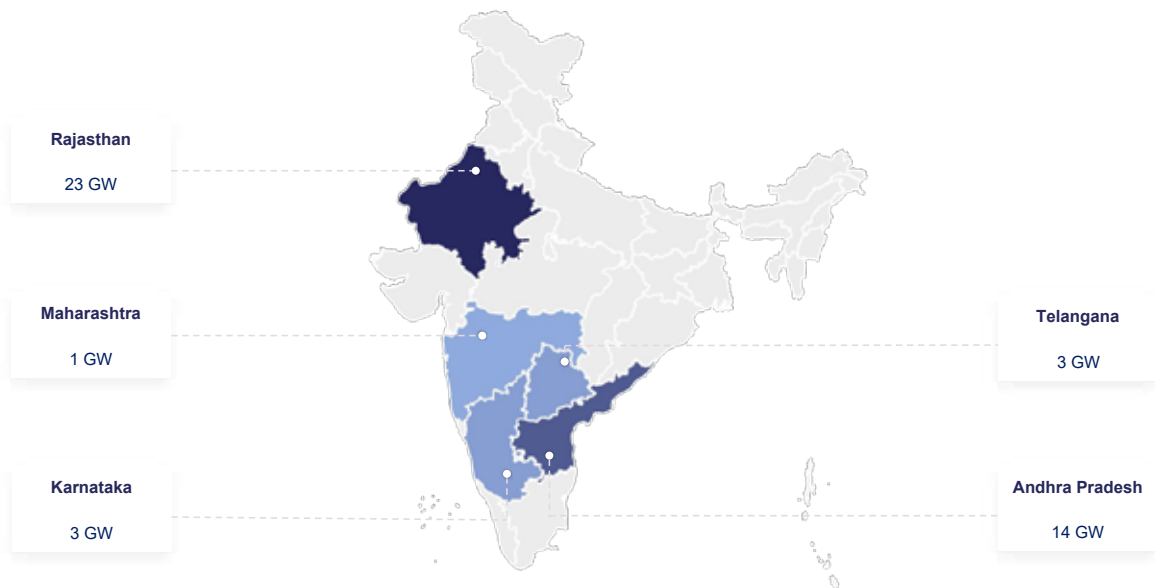
Cost-effective power management by DISCOMs through peak shaving, capping the energy costs at INR 4.8/unit



BESS integration enables DISCOMs to achieve strategic cost efficiency, mitigate peak hour expenses and ensure reliable energy at optimized rates

India Plans BESS Addition of 44+ GW by 2030

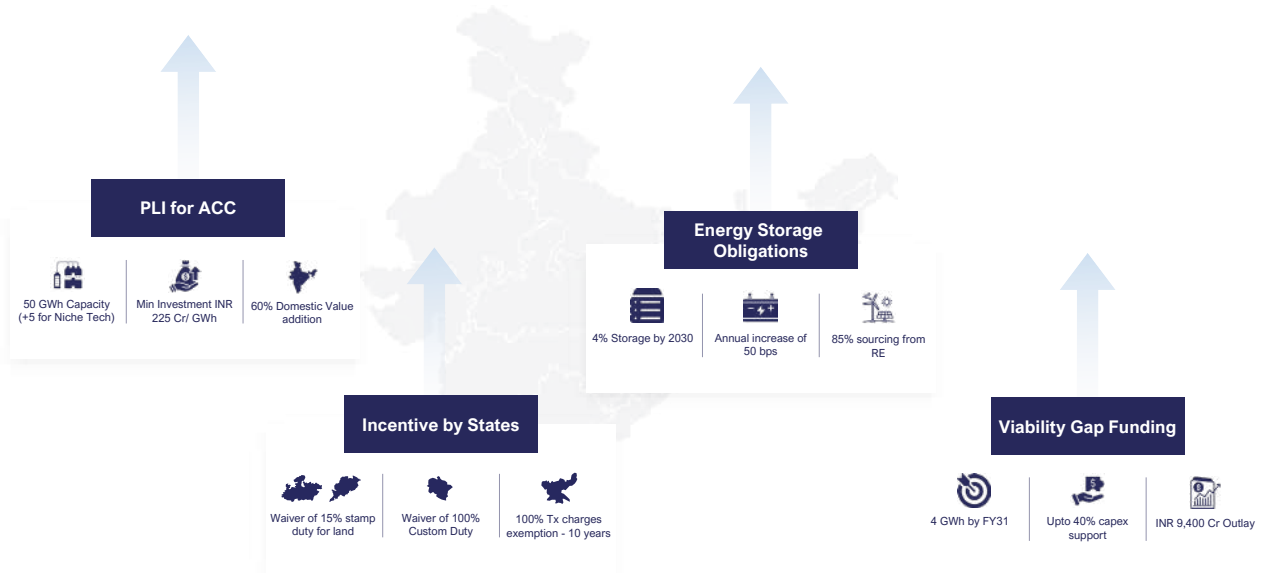
Energy independence by 2047 and net zero by 2070 will require a significant BESS infrastructure in India



Source: CEA

Governmental Push for BESS

Accelerating Energy Storage Growth: Policies and Incentives Driving BESS Development



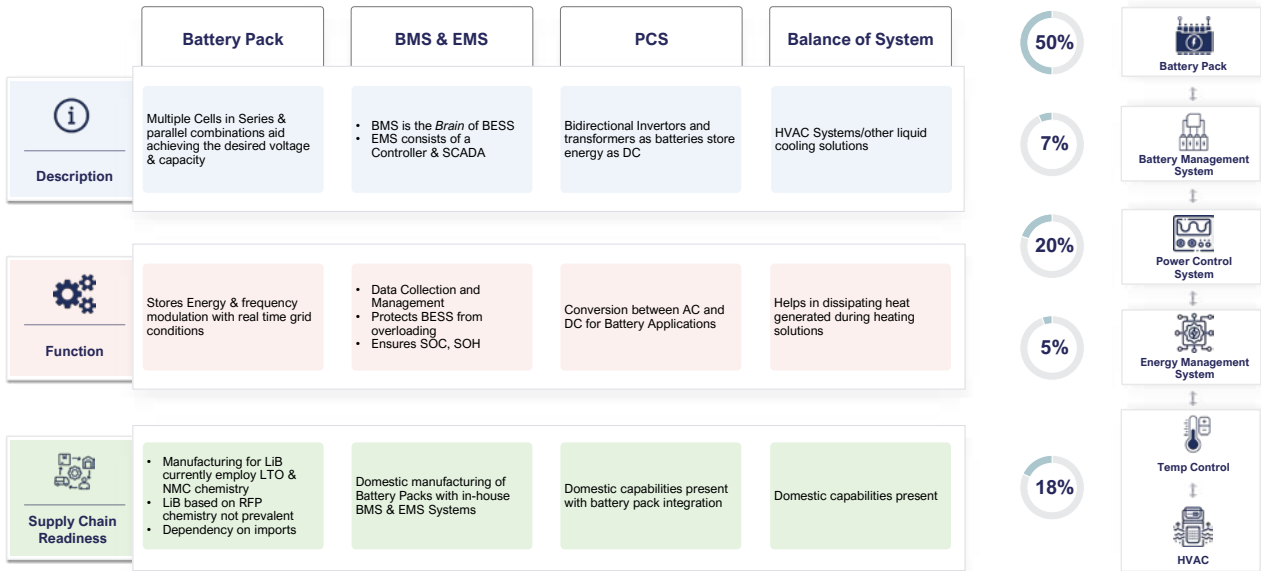
Tx: Transmission, PLI for ACC: Production Linked Incentive for Advanced Chemistry Cells

Operating Mechanics



Description & Functions of BESS Components

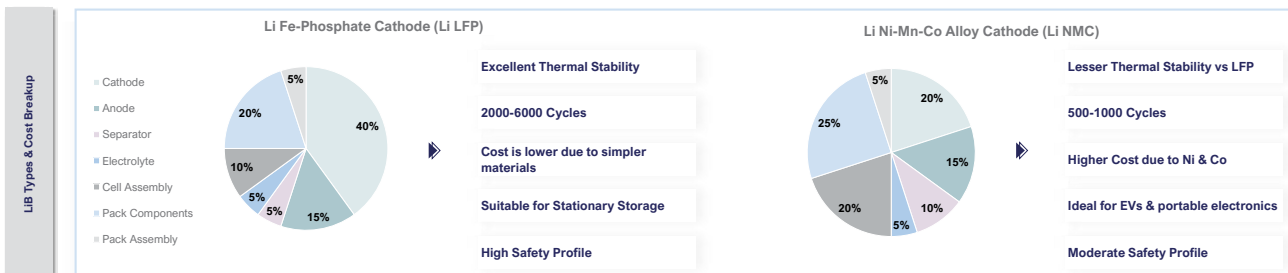
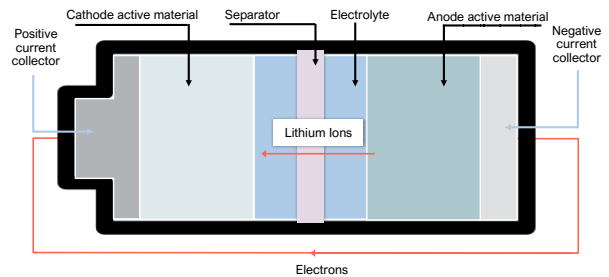
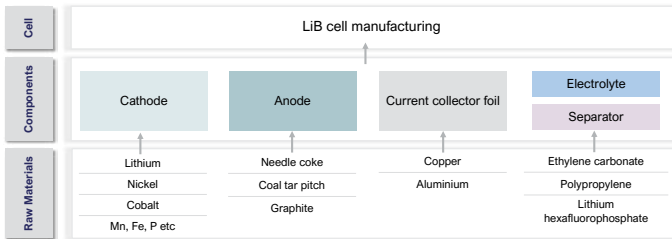
Evaluating the various components of BESS & supply chain readiness of these components



Key Components of a LiB Cell

Description of the various cell chemistries prevalent in LiB and properties

LiB Manufacturing Value Chain



Source: Niti Aayog, Bloomberg NEF

Key Considerations for a BESS Project

Determination of Capex & Tariff involves comprehensive assessment of various factors

Tariff Discovery	Capex Split	Specifications	O&M	Other Factors
Financing Considerations Tariff will be impacted by Debt-Equity mix, Cost of capital and forex hedging	Land Acquisition Cost Installation of battery containers and ancillary infrastructure in urban vs rural areas	Battery Capacity Advanced engineering and increased safety considerations for higher capacity systems	Operational Costs Monitoring, preventive maintenance, system upgrades, and warranty management	Regulatory Approvals Adherence to CERC/SERC guidelines and approvals for grid interconnection
IRR Expectation Long contract period, balanced with capex and revenue streams like ancillary services, peak shaving	Equipment Cost Includes battery packs, inverters, transformers, cooling systems	Round-Trip Efficiency Directly impacts operational viability and long-term performance	Optimization Predictive analytics, AI, and real-time data to enhance performance and reduce downtime	Inflation Rising material costs of battery like lithium, nickel, and cobalt
	Technology and Automation Integration of EMS, SCADA, and AI optimization tools	Duration Energy discharge duration determines the use case feasibility		Forex Impact Currency fluctuations affecting the import of battery inputs

Salient Features of the Battery Energy Storage Purchase Agreement

Key terms governing a battery energy storage purchase agreement between developer and Utilities

Features	BESPA terms		
Contract Period	12 years from Scheduled Commissioning Date / date of full commissioning, whichever is later		In case of Force Majeure, extension of scheduled commissioning date and expiry date is permitted
Tariff Price and Incentives	Bid tariff fixed for the entire term	Maintain Annual 95% Availability	Maintain 85% RIE. RIE>85%, Incentive of INR 0.5 per unit of excess discharge
Performance Security	Performance bank guarantee/ Payment on order instrument of predetermined value to be deposited by developer in favor of SECI		
Implementation Schedule	Project will take approximately 18-24 months (as applicable) to get completed from the effective date		
Force Majeure	SECI/ BESSD excused to perform obligations for 180 days, can be extended on mutual agreement	Extension of contract period is allowed for FM events affecting SECI/ Buying entities/ BESSD	
Damages / Penalties	Availability <95%. Developer shall pay liquidated damages as per BESPA	RTE <85%, liquidated damages applicable	Delay SCD results in liquidated damages, event of default and BESPA can be terminated
Miscellaneous	Developer to achieve financial closure in 9 months	Developer not allowed to schedule pre-decided cycles/day	Developer is responsible to obtain land/ consents, permits and clearance/ connectivity with CTU
CIL Claims	BESPA provides pre-defined formula for increase in tariff corresponding to increase in project costs for Change in Law		

RIE: Round Trip Efficiency

BESSD: Battery Energy Storage System Developer

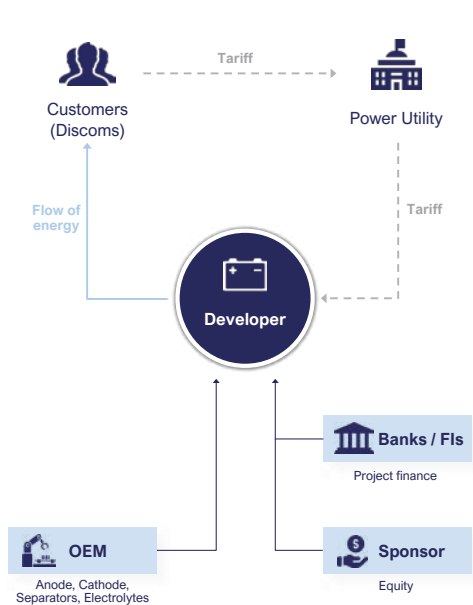
CTU: Central Transmission Utility

Risk & Return Dynamics



Operating Cycle with Returns, Risks & Mitigants

Operating cycle visualised with evaluation of the value pockets of Standalone BESS ecosystem

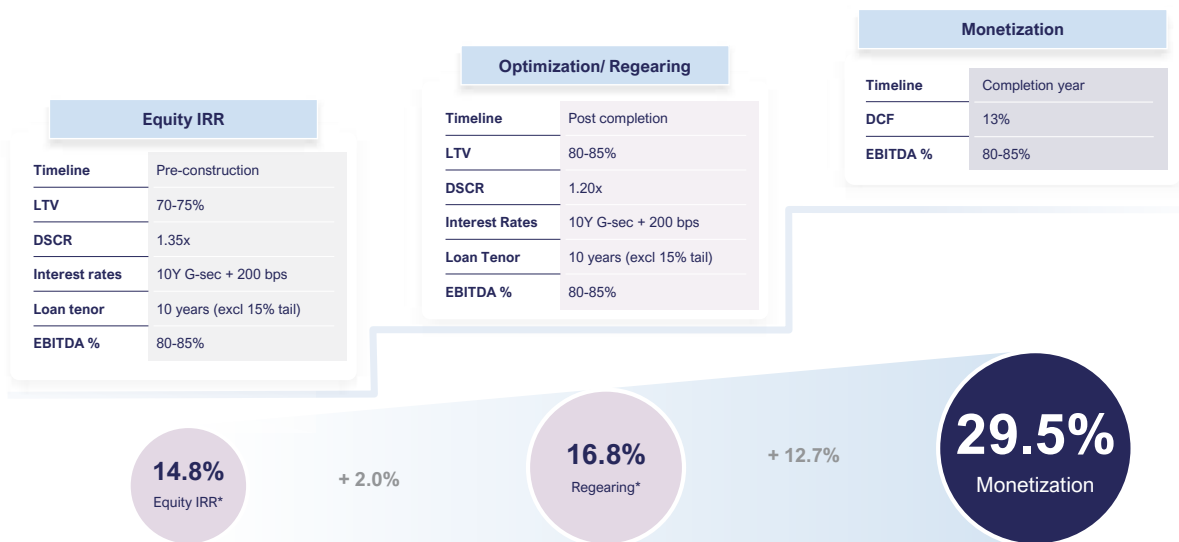


	Developer		OEM	
Average Returns	15% HTM IRR	30% Exit IRR	12-15% EBITDA margin	
Risks	Financing O&M	Overruns High Upfront Capex	Execution Working capital	Commodity prices Orderbook
Mitigants	Mature Credit 85% EBITDA	Claims Mechanism Low Gestation	Capabilities Contracts with Leading Developers	Hedging Large Capex Pipeline

Approximate returns and margins

Unlocking Value through Cap Rate Compression

Optimized construction timelines and monetization drive quicker capital redeployment



(*): Post tax



Market Mapping










BESS: Value Chain

Current Landscape of India's evolving Battery Storage Value Chain

Raw Material Processing								
Anode & Cathode Materials								
Electrolytes & Separators								
Cell Manufacturing								
Battery Pack Recycling & Assembly								
Battery Tech, Mgt Systems & BOS								
Developers								

Key Emerging Players in the BESS








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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	On-site, off-site solar, battery storage, and hawk AI energy monitoring system	2GW+ solar capacity	Private Company	710	41	-	Crisil AA+	First mover in the Indian industry to establish Battery Integrated Solar energy solution for C&I customers under OPEX model
	Manufacturing and supplying of polyethylene and phenolic resin battery separators	NA	Private Company	353	87	331	NA	NA
	Supplies Flow Batteries to 9 countries across 5 continents (North America, Europe, Australia, Asia and Africa) ranging from 10 kWh to multi-MWh capacity	NA	Private Company	6	1	3	NA	Awarded contract by NTPC to implement 3MWh Vanadium Redox Flow Battery (VRFB) based BESS project
	Manufacturing of lead-acid batteries for residential, commercial, EV applications. Sells its batteries under brand name; 'Addo' and 'Eastman'	4M+ annual battery manufacturing capacity	Private Company	2,334	157	365	Acuite AA-	Largest manufacturer of solar tubular batteries in India. Contract manufacturing for clients such as Fujiyama, Lucas Amara Raja
	Manufacturing of coal tar derivatives and carbon black products. Products include carbon black, specialty carbon derivatives and focus on Anode materials	Carbon black production cap-1,15,000 TPA	Private Company	3,006	699	-	Crisil A+	Plants of 30,000 tons each in US & India, largest anode facility outside China \$1.1 Bn MoU with Karnataka Government for EV Battery component production
	Manufacturer of automotive lead-acid batteries and a provider of stored energy solutions	346 KMT p.a of Lead Recycling Capacity	38,471	16,770	1,907	697	ICRA AAA	invested INR 100 Cr in EV subsidiary to fund a greenfield lithium-ion battery manufacturing
	Manufacturing of online ups, offline ups, inverters, battery chargers, solar management units, solar charge controllers, and batteries	1GW capacity, plans to expand to 5GW	Private Company	665	55	198	Care BBB+	UTL Solar, its subsidiary plans to set 5GW Capacity Unit in Madhya Pradesh and investment of INR 500 Cr

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS








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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Solar EPC engaged in providing solar designing and engineering services	770 MW+	3,026	3,890	1,485	167	ICRA BBB-	Won the 500 MW/ 1000 MWh standalone battery storage by GUVNL including GS Option 70 MW/140 MWh BESS project from GUVNL
	Engaged in designing and manufacturing batteries, rechargeable li-ion batteries, NA-ion batteries, all solid-state batteries, one of the largest R&D teams in India in sector	2.5 GWh capacity, plan to expand to 12.5 GWh	Private Company	1	-5	2	NA	MoU with Telangana Government to set up 12.5 GWh lithium-ion cell manufacturing unit with investment of ~INR 8,000 Cr
	Road EPC player , has currently won tenders for battery storage	10 HAM Projects	8,675	5,378	1,064	1,513	ICRA AA-	Recently won a RE + Storage tender of ~200 MW
	Manufacturing electronic powertrain systems. Its products include motors, inverters and battery control units	Reputed auto cos are customers	Private Company	1,790	323	1,470	Care A	
	Electrical infrastructure company, experience in deploying grid-connected and off-grid BESS Turnkey Solar, Electric Infra, Railways and management consultancy for Oil & gas	Cumm. installed capacity ~150 kW	Private Company	NA	NA	NA	NA	Secured BESS contract from NTPC: 250kW/1,200 kWh in Khavda
	PSP, BESS, green hydrogen	4.2 GWh of locked-in through BESS, PSP	Private Company	1,389	-48	-	ICRA AA	Secured 500 MW/1000 MWh capacity in SECI's 1,000 MW/2,000 MWh Battery Energy Storage Systems (BESS) auction (largest of such kind)
	EPC, provides technical consultation, project execution, installation and commissioning to power generation and distribution companies on a turnkey basis	NA	Private Company	177	14	28	CRISIL BBB+	Awarded 65 MW capacity in NVVN 500 MW/1000 MWh BESS auction Secured 100 MW capacity in GUVNL Phase IV BESS auction

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS








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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Manufactures lithium-ion battery packs: 3 wheeler battery packs, 2 wheeler battery packs, stationer segment battery pack etc	Recycling capacity: 2 GWh Reuse: 300 MWh	Private Company	308	24	48	Crisil BBB+	To set up 30 Mn battery processing plant In US, \$100 Mn capex plan to expand 2nd life battery recycling
	Manufactures power products, offers power back up solutions, voltage solution, solar energy and accessories	NA	Private Company	1,882	142	538	NA	-
	Mfg and supplier of electrical batteries, products incl inverter batteries, solar batteries, railway batteries, telecom batteries, wind power storage battery etc	Network of over 1,000 exclusive distributors	Private Company	1,046	22	128	NA	Sep'20: Bagged orders from BHEL for energy storage systems
	Design and mfg of industrial eqp, products incl solar inverter, pace solar power optimizer, power management unit, integrated power management system	NA	Private Company	516	41	192	NA	Mar'23, ~INR 7,033 Cr ordered (BSNL) for installation, O&M of telecom towers (7/14 circles)
	Green energy production, incl solar, EV, green hydrogen, clean energy solutions, and turnkey projects	EPC Solar: ~1.1 GW	Private Company	341	66	63	NA	Secured BESS tender
	Solar EPC, offers solar park and projects, operation and maintenance, rooftop solar, energy storage, and energy retail	EPC Solar: ~1 GW	Private Company	733	78	31	NA	Oct'24: Won 600 kW/3000 kWh VRFB System tender (NTPC) Jul'24: Raised INR ~1.3 Bn
	Products for low voltage, access to energy, solar and energy storage. Sectors :industrial, buildings, DCs, residential and smart cities segments	31 mfg plants	19,860	14,707	3,377	-	Crisil AAA	Launched a new BESS for microgrids

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS








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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Presence in aerospace, airports, automotive manufacturing, battery manufacturing, data centers, distributors, electronics industry etc	INR ~1,000 Cr capex for mfg facilities	2,69,257	3,104	684	-	Crisil AAA	Deploying a large-scale BESS with a capacity ~160 MWh in Ireland
	Mfg of inverters incl string inverter, central inverter, power conversion system/hybrid inverter, BESS, loading body, inverter and booster floating platform and accessories	Installed 605 GW of power eqp globally	Private Company	496	36	-	NA	1 GWh contract in Texas, 100MW/400MWh partnership for BESS in Malaysia
	Manufacturing lithium-ion batteries, battery module, battery management system, start and stop system devices	Exp to each 50 GWh global capacity soon	Private Company	4,277	159	423	NA	partnering with Gryphon Energy to develop a 1.6 GWh battery energy storage project,
	Mfg and supplying of lithium-ion batteries to automotive sector. JV between Toshiba Corporation (40%), Denso Corporation (10%) and Suzuki Motor Cor (50%)	Plan to expand to 30 Mn cells/year	Private Company	1,494	507	NA	NA	Export lithium-ion battery cells and modules INR ~750 crore, Parent signed MoU with Gujarat govt to invest INR ~5k crore
	Leader in Flake Graphite mfg over 2 decades. Into Graphite mines and processing plant. Partnership to build Mines and processing plant in Madagascar.	To est. 24,000 TPA graphite processing facility	Private Company	NA	NA	NA	NA	Commences full-scale operations at Vatovina graphite project
	RE company, backed by EQT. Generation and energy storage technologies, including solar, wind, batteries and green hydrogen	Target: 5.3 GW	Private Company	19	14	11	NA	Currently have 3 GW
	Mfg batteries, power electronic products and precision engineering parts	11 mfg facilities, 50+ Mn units annual prodn. capacity	23,480	11,708	1,769	6,799	Crisil AA+	Plans to increase its current lithium-ion cell manufacturing capacity to 25 GWh/year

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS








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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Offers nanotechnology products including oil sorbent, graphene composite filtration media, post-purification filter	Li cell 50 MWh, battery pack 250+ MWh	Private Company	72	-65	138	NA	Partnership to support next-gen EV Powertrain technology with Musachi, Jupiter Wagons acquired Railway & Electric truck battery division
	Manufactures electric vehicles and core components for electric vehicles. These components include battery packs, motors, and vehicle frames	Gigafactory Initial size 5GWh, expand to 100GWh	41,118	5,010	-1,034	5,363	ICRA A	Plans to use self manufactured batteries in EV segment
	Manufactures bromine and lithium-based organic and organo-metallic compounds	Organic chem 4.6 Mn cu. Mt, Inorganic, 39 Mn cu.mt.	5,546	691	118	394	Crisil A	Building a battery material facility in Gujarat, producing 30,000 MT electrolytes & 3,000 MT electrolyte salts
	Development of Green Energy Technologies & Products and its manufacturing- Li-ion cell technologies and product	Aim to scale to 30 GWh+	Private Company	1,052	153	303	NA	Completed its commissioning 600MWh annual capacity LFP cylindrical cell manufacturing
	Manufacturing graphite electrodes and electric power, In carbon specialty, it offers activated carbon fabric (ACF)	Planned 2k crore capex by FY25	Private Company	2,393	382	619	NA	World's Largest Single Site Graphite Electrode Plant under one roof with a capacity of 80,000 tons pa
	Manufacturing of carbon black. Its products are carbon black, specialty black, power	Carbon black mfg, capacity 770 kT	Private Company	6,420	1,037	4,983	NA	PCBL & Kindia -51:49 JV agreement in Nanovace for developing Nano-Silicon products to be used in anodes of Li-Ion batteries
	Manufacturing lithium-ion batteries. Its services include digital collection, testing and grading, cell auditing, repurposing, refabrication, sales and battery swapping	NA	Private Company	82	62	52	NA	-

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS







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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Mining services, incl Black Mass, Lithium, Nickel, cobalt, magnesium, secondary products, and manganese; battery grade materials by recycling end-of-life Li-batteries	NA	Private Company	21	-	-	NA	Partnered with LW3 to transform battery lifecycle management for energy storage system
	Manufactures semiconductors, specializes in analog, digital, and software technologies, provides battery management systems (BMS) and other products for the battery industry	~1.7 Bn R&D investments made at group level	Private Company	672	124	-	NA	Strategic alliance with Tata group for expanding facilities
	Conglomerate, leading textile company in India Hydro-based, wind, thermal power generation	Commissioned 2 Hydro power, 2 wind power plants	Private Company	10,104	1,633	-	NA	Won GUVNL BESS tender in Dec'24
	Product solutions for power transmission, substations and telecom infra	200 MW Electrolysers capacity planned	1,600	209	36	16	Crisil BBB	Won GUVNL BESS tender in Dec'24
	Mfg of power systems in EV batteries, power systems, RE & grid hybrid systems	4.5+ Lakh Li-ion Batteries deployed	Private Company	1,020	131	30	NA	Aug'24: Potential acquisition of Australian EV Charging company
	Manufacturing of carbon materials and chemicals, key player across battery materials, coal tar pitch, carbon black, naphthalene, SNF	Panned 20,000 MT advance carbon material capacity	28,150	4,185	645	-	ICRA AA-	Acquired 40% stake in Li-ion battery material startup Invati Plan to invest INR 220 Cr in carbon black
	Mfg battery materials- cathode & anode	Target: 6GWH by 2026	Private Company	NA	NA	NA	NA	Jan'24: Aims to invest USD ~100 Mn in cathode mfg over next 5 years

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS





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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	World's leading sustainable manufacturer and supplier of carbon black additives and largest producer and supplier in carbon black	382,200 TPA production capacity	Private Company	4,145	739	-	CRISIL AA	USD 1 Bn investment to build synthetic graphite and supplying battery materials for EV battery and defense
	Mfg chemicals, wholly owned subsidiary GFCL EV raised INR 1,000 Cr to expand its battery material capacity	1,800 TPA Li plant recently commissioned	1,069	4	-8	-	CRISIL AA	GFCL EV raised 1,000 Cr to expand its battery material capacity, supporting ~5-6 GWh production
	Production of specialty films relevant to battery storage applications, developed chemical recycling processes	Thin PET 1,86,000 MTPA, thick PET 28,800 MTPA	4,187	6,307	366	42	IND AA-	-
	Jindal renewable energy is into BESS component manufacturing like battery packs, cell manufacturing etc	To expand cell manufacturing cap. To 5GWh by 2027	NA	NA	NA	NA	NA	Plans to establish a 1 GWh battery pack assembly line using lithium iron phosphate (LFP) chemistry by 2025
	Production of specialty chemicals, including inks and adhesives, which are essential for various applications in battery storage and packaging	Global manufacturing capacity 1 Mn+ MTPA	4,116	13,364	1,387	5,874i	IND AA-	-
	Custom mfg of specialty chemicals, including agrochem & pharma intermediates for use in battery tech, involved in fluoropolymers for battery casing and lithium applications	27,200 MTA manufacturing capacity	8,092	1,475	381	781	IND AA-	Acquired 26% of specialty fluorides chemical manufacturing business Tanfac from Birla Group Holdings
	Involved in the production of specialty chemicals and carbon black, exploring new technologies and processes to enhance their product offerings in the battery sector	36,661 MTPA for specialty chemicals	68,236	13,139	2,584	4,623	CRISIL AA+	Investing ~INR 15,000 Crs to expand facilities

Market Cap (Dec'24) INR Cr

Key Emerging Players in the BESS

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

Companies	Description	Scale	Market Cap	Revenue	EBITDA	Net Debt	Rating	Updates
	Mfg of lithium-ion cells for electric vehicles, Subsidiary of Tata Sons Ltd.	Planned capacity: 20GWh	Private Company	-	-33	-	Care AA+	Jan'24: Planned to raise green loan of USD ~500 Mn
	Battery mfg, solar solution provider, offers ev-2 wheeler, e-rickshaws battery, solar hybrid solutions and ESS	Production Capacity: 1.2GWh	Private Company	47	-6	22	NA	Sep'24: Cygni Energy partners with XDLE for energy storage solutions Aug'22: Raised USD 12.5 Mn to drive growth and expansion
	Mfg auto electrical parts, offers automotive products. JV between Lucas Plc. UK and TVS Group. Set up ~10 GW LiB factory in partnership with 24M	Presence in 5 countries	Private Company	4,185	324	-	Crisil AA+	Apr'24: Bid for Govt's ACC PLI Scheme Sep'21: Built a LiB factory with US Co tie up, capex INR ~2,500 Cr
	Engaged in supply, installation and maintenance of smart meters for power distribution companies and trading in lithium cells	Target LFP: 5 GWh	Private Company	NA	53	30	Crisil BBB-	Awarded 80k smart meters projects- INR 155 Cr; Building capacity LFP cell plant of capacity 1 GWh, capex INR 1,100 in 3 years

Market Cap (Dec'24) INR Cr

Capitalizing on the Opportunity

Recent Awards in Standalone Battery Energy Storage

	Dec'24	Nov'24	Mar'24	Nov'23	Sep'23	Apr'23	Oct'22	Apr'22	Apr'22
Winners									
Capacity MW	500	500	500	250	20	0.3	50	10	500
Capacity MWh	1,000	1,000	1,000	500	40	1.2	200	20	1,000
Tendering Authority									
Winning Quote INR /MW/ Month	INR 2.26 Lakh	INR 2.37 Lakh	INR 2.37 Lakh	INR 4.49 Lakh	INR 4.75 Lakh	NA	INR 11.80 Lakh	INR 11.25 Lakh	INR 10.83 Lakh

ELGi

PG Series

Electric Portable

Screw

Compressors



ELGi's PG Series Electric Portable Screw Compressors are engineered to deliver high performance while setting a new benchmark in eco-friendly, portable compressed air solutions. Compressed air solutions are important for construction, mining, oil and gas industries. Designed for industries where clean energy, reduced emissions, and operational efficiency are top priorities, these compressors combine advanced technology with a compact footprint.



In sectors such as construction, mining, and oil and gas, compressed air is a critical utility. Drilling presents both technical and commercial challenges, demanding solutions that deliver speed, reliability, and efficiency. ELGI's PG Series addresses these needs across a wide range of applications including DTH drilling, oil and gas exploration, tunnelling, pigging, sandblasting, quarrying, piling, laying of fiber cables, road, and bridge construction.


The PG Series Electric Portable Screw Compressor (126-550 CFM, 102-232 psi(g)) are best suited for environmentally conscious customers. The air compressors are ideal for work environments where electricity is readily available in work environments that require quiet and emission-free conditions. The compressor has an electric system powered by a three-phase TEFC squirrel cage motor with 'F' class insulation.

Key Benefits

- **Energy Efficiency:** The η -V rotor profiles are designed to maximize energy efficiency, hence minimizes energy expenses.
- **Durability and Protection against Corrosion:** the compressor canopy is made of powder-coated industrial-grade steel, and the cool-box design allows cool air to enter the rear of the compressor (in closed-door operations) and wash over internal components, to keep the internal temperature low and extend component life
- **Maneuverable in Small Spaces:** The PG series is compact and maneuverable in small spaces,

making it capable of short radius turns in narrow spaces.

- **Increased Operational Life:** It is ideal for dusty environments as the two-stage filtration system keeps dust out of the compressor and engine.

These compressors are best-suitable for standard pressure applications, including powering breakers and tools in marble, granite, and blue metal quarries, and more specialized applications such as sandblasting, pigging, drilling, and optical fiber blowing as they are engineered for high uptime and easy maneuverability. The user-friendly controls and robust design ensure both operator comfort and lasting performance. 





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
- Exhibitions
- Press Conferences
- Employee Engagement Activities
- 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

Designing Childhood: The Power of Mobility Toys

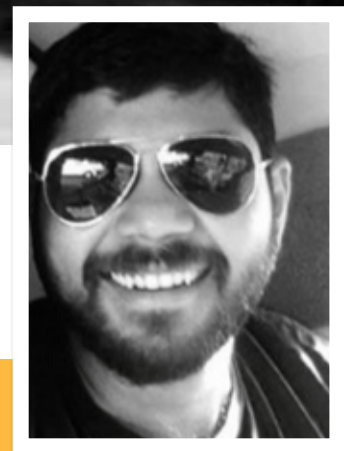
Mobility toys like tricycles, scooters, and ride-ons are much more than playthings—they are vital tools in early childhood development. With India's mobility toy market crossing ₹1,000 crore, there's growing awareness of their developmental value. However, the sector remains largely unorganised and under-designed. Emphasising safety, age-appropriate design, and developmental benefits can transform this market and unlock greater impact for both children and the industry.



Mobility toys—such as tricycles, scooters, balance bikes, ride-ons, and push cars—are more than just tools for play. They are essential to a child’s developmental journey, encouraging physical movement, sensory engagement, social interaction, and emotional confidence. In the early years of life, when every movement, reaction, and exploration becomes a building block for motor and cognitive development, mobility toys act as a catalyst for growth.

The segment is gaining visibility with

India’s children’s mobility toy market now valued at over ₹1,000-1,500 crore and growing fast. Yet, it remains largely unorganised and fragmented, with limited emphasis on purposeful toy design. With India’s domestic toy industry currently at around 1% of the global market, at \$1Bn, there is immense potential to scale both domestically and for export. A shift toward design-led, age-appropriate, and safety-focused mobility toys could unlock new levels of impact, not just for the industry but for millions of children growing up in India.



**Aditya
Krishnakumar,**
Co-Founder, BIDSO



Tool for development

The importance of mobility toys in early childhood development cannot be overstated. At every age milestone, a thoughtfully designed toy supports the child's evolving physical and cognitive abilities. For toddlers aged 1-3 years, ride-on push cars and foot-to-floor vehicles help develop gross motor skills, leg strength, and balance. At this stage, toys should have wide bases for stability, ergonomic seating, and low-speed movement to prevent accidents.

Between the ages of 3 and 5, toys such as tricycles, balance bikes, and beginner scooters come into play. These toys aid coordination, encourage independence, and help build core strength. For older children aged 5 and above, more advanced scooters and bicycles can enhance agility, spatial awareness, and confidence in navigating real-world environments.

The design of these toys must evolve with the age of the child. Features like adjustable seat heights, safety harnesses, soft handles, and reinforced frames are no longer optional—they are essential. A tricycle that's too tall or a scooter without a stable deck can do more harm than good. Age-appropriateness in toy design ensures not just safety but also maximises engagement, helping the child reach key developmental goals through active play.

Ensuring safety

India's toy market—particularly the mobility category—was once dominated by low-cost, low-safety imports and unregulated local products. This began to change with the introduction of BIS (Bureau of Indian Standards) regulations in 2019. Today, the challenge lies in Indian manufacturers being able to meet required safety and design standards at scale, both for domestic and export markets.

Parents must be cautious not to buy toys with poor build quality, lacking non-toxic certifications or adequate structural support. This is where standardisation

and regulation in mobility toy manufacturing become crucial, ensuring safety and reliability.

BIS certification thus is a step in the right direction, but awareness among consumers and compliance by manufacturers needs to rise significantly. Safe toy design includes non-toxic materials, rounded edges, secure joints, anti-slip tyres, and weight-tested structures. Companies investing in long-lasting, safe, and ergonomically designed mobility toys will not only earn consumer

trust but also elevate the perception of Indian toy quality on the global stage.

Opportunity in the sector

Despite the market for kids' mobility toys crossing ₹1,000 crore, it is still largely unorganised. This creates both a challenge and an opportunity. With increasing awareness among urban Indian parents around developmental milestones and play-based learning, there is a rising demand for structured, durable,

and thoughtfully engineered toys.

Brands that invest in innovation, design R&D, and compliance with global safety norms are well-positioned to lead this space. India's push for "Make in India" and the curbing of cheap imports offer an incentive to domestic players to build strong homegrown brands. Toy manufacturers that collaborate with child psychologists, physiotherapists, and product designers can unlock deeper insights into how children play and learn.

In an age of screen saturation and






“

Despite the market for kids' mobility toys crossing ₹1,000 crore, it is still largely unorganised.

digital distraction, physical play is more important than ever. Mobility toys not only get children moving but also teach them spatial awareness, resilience after falls, and a sense of agency. When children propel themselves—whether on a scooter in the park or a tricycle on a quiet lane—they gain confidence, build stamina, and begin to understand the world on their terms.

With the right design thinking, investment in quality, and education around the role of mobility toys in child development, we can shape a generation that grows not just faster or stronger, but smarter, safer, and more self-assured. As toy design becomes central to this movement, mobility toys will no longer be viewed as just playthings but as powerful tools in a child's journey toward physical, cognitive, and emotional wellness. 

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



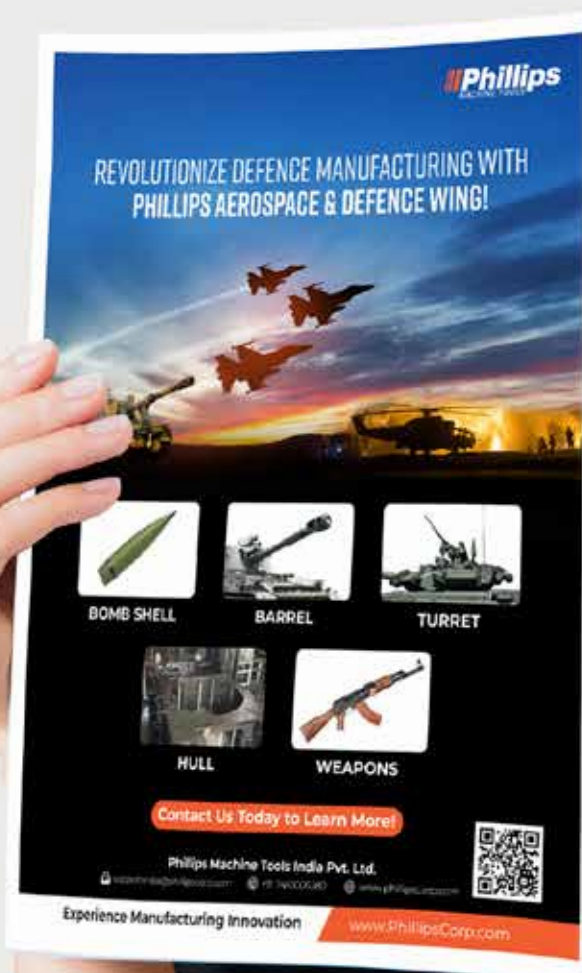
the IDEAL



SPACE FOR YOUR PRODUCT OR SERVICE

www.machineedgeglobal.com

+91 9766042062





Smart Tech for Smarter Biofuel Storage

Biofuels are a crucial part of the clean energy transition, but their storage and distribution pose unique challenges. Technologies like IoT and AI are now transforming biofuel inventory management by enabling real-time monitoring, predictive maintenance, and data-driven decision-making. These smart solutions improve quality control, reduce waste, and enhance operational efficiency—paving the way for a more sustainable and autonomous biofuel ecosystem.



Kishan Karunakaran, Founder and CEO, Buyofuel

In the rapidly evolving energy landscape, biofuels have emerged as a vital component in the transition towards cleaner alternatives. However, managing the storage and distribution of biofuels presents unique challenges that differ significantly from those associated with fossil fuels. These include variable feedstock quality, degradation over time, and the logistical intricacies of decentralized production.

To address these challenges, innovative technologies such as the Internet of Things (IoT) and Artificial Intelligence (AI) are playing an increasingly pivotal role in redefining inventory and storage management for biofuels.

The Unique Challenges of Biofuel Storage

Unlike petroleum-based fuels,

biofuels are organic and prone to microbial contamination, oxidation, and separation if not stored properly. They also tend to vary in consistency due to differences in feedstock sources, making quality monitoring essential. Furthermore, biofuel production is often decentralized, especially with small-scale processors and micro-refineries, which complicates coordination and inventory visibility across sites.

These factors create an urgent need for smarter, more adaptive storage solutions that can maintain quality, minimize loss, and streamline supply chains. This is where IoT and AI technologies step in.

IoT: Real-Time Monitoring and Predictive Alerts

IoT sensors can be embedded in storage tanks and connected throughout the supply chain to monitor a variety of parameters in real time. These include:

- Temperature and humidity levels
- Tank fill levels
- Pressure variations
- Presence of water or contaminants
- Viscosity and density of stored fuel

With these inputs, operators can receive instant alerts about potential spoilage, leaks, or abnormal conditions. This not only reduces operational risks but also ensures that remedial actions can be taken before fuel quality is compromised.

Moreover, IoT devices can be networked across facilities to provide a centralized dashboard view of all storage units. This transparency is crucial for companies managing fleets of decentralized biofuel units, such as those in rural or off-grid areas.

AI: From Data to Intelligence

While IoT provides the data, AI transforms it into actionable intelligence. Machine learning algorithms can analyze patterns over time to:

- Optimize refill schedules and logistics routes
- Predict equipment failures or maintenance needs
- Identify anomalies in storage behavior that might indicate contamination

For instance, if a specific storage tank consistently shows higher degradation rates, AI can correlate this with

environmental factors or equipment issues and suggest targeted interventions.

In addition, AI-driven inventory management systems can dynamically adjust stock levels, avoiding both shortages and overstocking, thus enhancing operational efficiency and reducing costs.

Early adopters of IoT and AI in the biofuel sector have reported significant improvements in operational efficiency and risk reduction. For example, decentralized biodiesel producers are

now able to track and manage fuel quality remotely, ensuring compliance with safety standards and minimizing waste.

In the transportation sector, companies using bio-CNG or ethanol blends can optimize their fueling schedules and avoid service disruptions by integrating IoT-enabled tank monitoring with route planning algorithms.

Moreover, governments and regulatory agencies are beginning to recognize the value of digital infrastructure in ensuring the traceability and sustainability of





biofuels, especially with increasing focus on ESG (Environmental, Social, Governance) compliance.

Future Outlook: Towards Autonomous Biofuel Operations


The convergence of IoT and AI paves the way for autonomous biofuel storage systems. In such systems, storage tanks could self-monitor and auto-schedule maintenance or refills.

AI could even initiate automated reporting for compliance and carbon credit validation.

As 5G connectivity expands and sensor technology becomes more affordable, the barriers to adopting these smart solutions will diminish further. Startups and traditional energy firms alike are investing in digital transformation to stay ahead in the competitive landscape.

Smart inventory management enabled by IoT and AI is not just a

futuristic concept but an essential strategy for the present. By improving visibility, enhancing quality control, and optimizing logistics, these technologies can dramatically increase the efficiency and sustainability of biofuel storage systems.

As the global push towards renewable energy intensifies, embracing digital innovation in inventory and storage will be key to unlocking the full potential of biofuels. The future of energy is not only green but also smart. 

Is Lithium Still the Key to the **Future of Mobility?**



Karthikeyan A,
Co-founder & CTO, Raptee.HV



As the world moves steadily towards electric transportation and cleaner energy, the spotlight is firmly on lithium - a mineral that sits at the heart of this transition. Whether it's electric motorcycles navigating city roads or large-scale solar and wind projects storing energy for later use, lithium-based batteries are the common thread. But with demand growing faster than ever and other technologies catching up, it's worth asking: will lithium continue to drive the future of mobility, or is its time limited?

Why Lithium Matters More Than Ever

The unique properties of lithium make

it ideal for rechargeable batteries. Because lithium atoms are lightweight and highly reactive, they can store more energy in a smaller space. This makes batteries not only compact but also powerful - a crucial factor for electric vehicles, where every kilogram saved can mean extra kilometers of range. No other material currently offers this balance of performance, cost-efficiency, and commercial readiness, which is why lithium-ion batteries are used almost universally in EVs and renewable energy systems.

Recognizing this, India has launched an ambitious national strategy to secure its future access to lithium and other key minerals. The ₹34,300 crore National Critical Mineral Mission is focused on reducing dependency on imports by

exploring domestic reserves, investing in overseas assets, and building processing capacity at home. With ₹1,500 crore allocated from the Union Budget and public sector firms expected to contribute another ₹18,000 crore, the country is taking serious steps to strengthen its position in the global battery supply chain.

Where the World's Lithium Comes From

Lithium isn't rare in nature, but finding and refining it economically is a different story. Most of the world's supply comes from a few countries. Australia leads production through mining, while South American nations like Chile, Argentina, and Bolivia - often referred

to as the Lithium Triangle - hold over half of the planet's lithium resources, mainly in salt flats. China, despite having smaller reserves, dominates the chemical processing part of the supply chain, refining more than half of the world's lithium output.

This concentration of supply in a few regions poses challenges. Any disruption - be it geopolitical, environmental, or economic - can cause ripple effects across the globe. That's why many countries, including India, are now prioritizing local exploration and forming new trade partnerships to reduce their exposure to international risks.

Can Lithium Meet the Growing Demand?

The surge in electric vehicle sales, energy storage projects, and personal electronics means global lithium demand is expected to grow several times over in the next decade. While current reserves are projected to last for many decades, this will depend heavily on how efficiently the world can extract, process, and recycle lithium.

Recycling, in particular, is seen as a game-changer. As more used batteries become available, extracting lithium from them can significantly ease the pressure on natural reserves. By 2040, experts believe that nearly a third of the global lithium supply could come from recycled materials. This not only makes economic sense but also supports sustainability by reducing mining activity and its environmental impact.

What Are the Realistic Alternatives?

Emerging alternatives to lithium-ion batteries span a spectrum of maturity, readiness, and application areas. Sodium-ion batteries are gaining attention as a near-term low-cost solution, especially for micro-EVs, scooters, and stationary storage. While they offer resilience

in cold climates and energy densities approaching lithium iron phosphate (LFP) batteries, their growth is expected to remain niche-reaching perhaps 3% of the global battery market by 2035-until manufacturing scales and energy density improves further.

Solid-state lithium-metal batteries promise significantly higher energy densities, faster charging, and improved safety. However, large-scale commercialization is still years away, due to challenges like stack pressure control and high costs. They may first appear in premium electric vehicles in the late 2020s, with broader adoption expected in the 2030s.

Lithium-sulfur batteries, boasting theoretical energy densities up to 2600 Wh/kg, hold promise for weight-sensitive applications like drones or aerospace. But with limited cycle life (~500 cycles),

they remain confined to test labs and specialized use cases for now.

Hydrogen fuel cells, too, play a role-particularly in heavy-duty and long-range applications such as buses or commercial fleets. Passenger use remains low due to sparse refueling infrastructure. While the hydrogen market touched \$2 billion in 2024, its EV application is expected to grow mainly through fleet-focused commercial vehicles over the next decade.

Each of these alternatives presents unique trade-offs in cost, energy density, lifecycle, and ecosystem readiness. While promising, none match lithium-ion's all-round viability today.

Why Investment Still Favors Lithium

Despite the buzz around alternative technologies, most of the research



and investment in the battery space continues to be focused on lithium. Global companies are spending billions to improve lithium battery chemistry - making them last longer, charge faster, and become more efficient. According to the International Energy Agency, around 70% of all battery R&D investment in 2023 went toward lithium-based technologies.

India is following suit. A significant portion of its funding under the National Critical Mineral Mission is aimed at supporting lithium exploration, refining, and battery innovation. Private companies, government agencies, and research institutions are working together to build a strong ecosystem that can support domestic EV and renewable energy goals.

Recycling: Extending Lithium's Lifespan


What gives lithium even more staying power is the growing focus on battery recycling. As EVs age and reach end-of-life, the ability to recover lithium and reuse it in new batteries is becoming commercially viable. This not only reduces waste but also strengthens supply security and lowers costs in the long run.

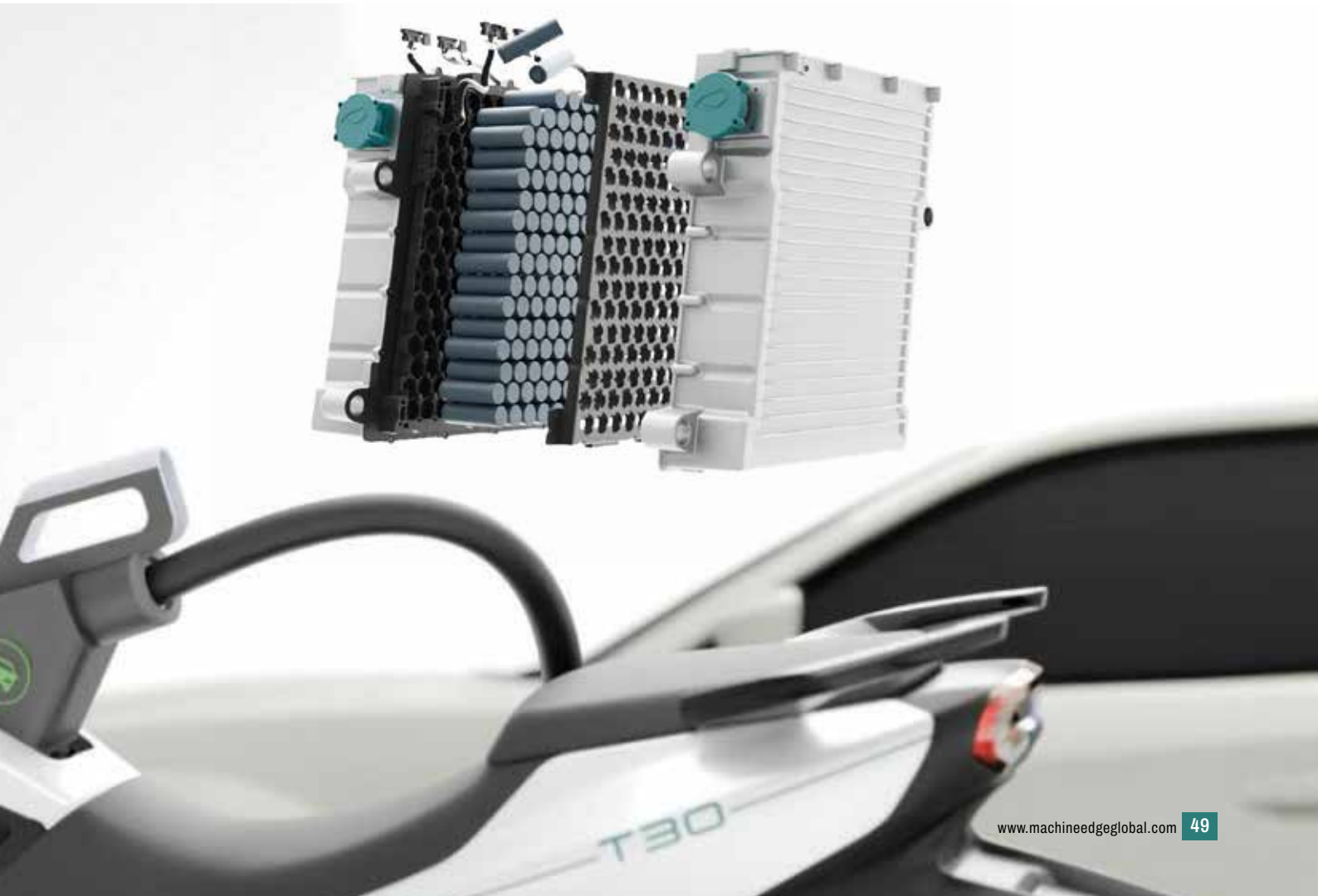
India's upcoming recycling incentive scheme, backed by the Mines Ministry, is expected to create a strong secondary market for lithium and other critical minerals. By encouraging battery makers and recyclers to close the loop, the country can reduce import dependency while building a more sustainable industrial base.

The Road Ahead

While new battery technologies will undoubtedly evolve and carve out

space in the market, lithium continues to lead the pack by a wide margin. Its unique combination of performance, maturity, and industrial support makes it the most reliable choice for the current and next generation of electric vehicles and energy systems.

Lithium-ion packs offer the highest practical energy density today-ranging from 150-275 Wh/kg depending on the chemistry-enabling lighter and longer-range vehicles. Fast-charging capabilities, reaching full charge in under an hour, and exceptional longevity with 1,000-10,000+ cycles in some variants, further cement its dominance. Add to this a globally mature manufacturing base (2,000 GWh capacity as of 2023) and a recycling process that recovers over 95% of metals in pilot plants, and it becomes clear why lithium is irreplaceable in the near term. 



Why Digital Textile Printing is Key to Greener Manufacturing?

Digital textile printing is revolutionising the textile industry by offering a faster, cleaner, and more flexible alternative to traditional methods. It significantly reduces water, energy, and chemical use while enabling customisation, small-batch production, and rapid innovation. As global textile hubs embrace this shift, digital printing is proving to be a sustainable and economically viable game-changer for the entire value chain.



Digital printing is steadily redefining the landscape of the textile industry. Across leading global textile hubs—from Surat in India to Guangdong in China and Milan in Italy—a quiet revolution is underway as manufacturers move away from conventional dyeing and printing techniques toward more advanced, sustainable, and flexible digital solutions. Initially met with skepticism, digital textile printing is now gaining widespread acceptance for the speed, precision, and cost-effectiveness it offers. More significantly, it addresses one of the industry's most pressing issues: sustainability. With growing awareness around environmental impact and increasing demand for customisation and rapid production, digital printing is emerging not just as an alternative—but as the future of textile manufacturing.

Digital Printing is increasingly becoming the mainstay of the textile sector, thanks to the all-encompassing benefits it offers to every stakeholder of the textile sector.

From Surat in India to Guangdong in China and Milan in Italy, textile hubs globally are undergoing a silent yet transformative change. Firms are ditching traditional dyeing and making a switch to more advanced, tech-oriented digital printing methods. First met with a bit of cynicism, the move is now gaining more recognition and support throughout the industry. In fact, many experts are touting this shift as a game-changer for the prospects of the textile industry. Not only does digital printing bring speed, flexibility, and huge cost savings, but it also addresses the critical challenge of sustainability that the sector industry has been contending with for a long time. Moreover, digital capabilities can play a critical role in reducing turnaround



Satish Panchani,
Co-founder & CEO, True Colors Limited



times, developing agile supply chains, and offering customised designs to consumers. With so many benefits on offer, here's a complete lowdown on how digital printing is revolutionising the textile industry by creating a win-win situation for all stakeholders:

Conventional Printing: Cost and Environmental Economics

The textile industry is among the largest employment generators in the world, making it crucial for economic growth and social development. Unfortunately, the sector is also infamous

for its hugely polluting nature. Sample the report of the World Bank, which reveals that 20% of the industrial water pollution globally is caused by the textile sector alone. As untreated water from textile units flows into the rivers, they not only pollute the water sources but also seep into the ground, causing serious challenges to the health of the communities. Conventional printing of textiles also requires huge quantities of water, which further pressurises the already strained levels of water resources. In addition, traditional textile units consume a large amount of electricity and also result in significant wastage of fabrics. Moreover,

textile firms with conventional methods can't offer customised designs, nor can they produce efficiently if the order quantity is not large.

Digital Printing: Notching up the Game

Powered by inkjet, digital printing is taking the textile sector to new heights of design, style, and efficiency. The tech allows direct printing on the fabric, leading to significant cost and time savings for the firms. In comparison to conventional printing, digital printing is fast, reliable, and significantly more





flexible. Here are the prominent benefits associated with digital textile printing:

Water Conservation:

The pressing need to conserve water is among the significant advantages that digital printing has to offer. In contrast to 200 litres of water required to print 1 kg of fabric in conventional printing, the digital technique virtually needs no water at all. This means that 10 kg of conventional printing would lead to 2000 litres of water, while the switch to digital could save the entire quantity of this precious resource. The savings are specifically significant in water-constrained areas and help firms operate frugally in terms of water usage.

Reduced Chemicals:

The ink used by the digital printers is eco-friendly, bereft of any hazardous substances. Unlike conventional printing, where the use of bleaches, dyes, and fixatives is the norm, digital printers use completely safe ink without any harmful impact on either people or the environment. Further, the minimal to no post-treatment of the fabric in the case of digital printing makes the technology more viable and sustainable in the future. The use of safe ingredients also helps in the conservation of the soil and keeps groundwater from being contaminated with harmful substances.

Energy Efficiency:

By eliminating intermediary processes that are part of the conventional printing, digital printing results in significant savings in energy consumption. The heating and drying in conventional printing consume a lot of electricity. The post-treatment procedure is equally cumbersome and needs massive amounts of power to operate efficiently. The digital printing, on the other hand, is specifically targeted and needs only low-heat curing at the end of the process. No wonder, the carbon footprint of digital printing is almost 60% lower than the conventional one.

Minimal Wastage:


The revolutionary on-demand printing feature offered by digital tech enables textile firms to produce in a customised manner. The production in small batches has also been made possible by digital printing. The digital printer lowers entry barriers by reducing the setup cost for new firms and entrepreneurs. This democratisation is necessary for ensuring the sustainability of the textile industry and makes it more vibrant and competitive. Further, digital printing reduces overproduction and

fabric wastage associated with the mass production of fabrics. This brings down the inventory costs, besides making the entire value chain agile and responsive.

Speedy Innovations:

Firms using digital textile printing are leading the innovation race in the market. The digital capabilities allow designers to create, experiment, and innovate as per the changing aspirations of the customers. As designs are digital, they can be (re)worked and altered without putting the resources at risk, something that is the case with conventional printing. Digital printers also eliminate the need for stencils or physical screens, which means creativity can spread its wings far and wide without any inhibitions.

Conclusion

Digital textile printing offers holistic benefits to stakeholders. On the economic side, it brings significant savings on printing costs, electricity consumption, and inventory management. Personalised prints, small batch production, and responsive operations are also significant merits associated with the technique. The ecological quotient is equally strong as digital printing reduces the water consumption requirement. Besides, digital printers control the flow of toxins into the groundwater by using safe, toxin-free ink for the printing process. In addition, firms can foster a culture of creativity and experimentation with the help of digital printing. More importantly, digital textile printing has enabled a level playing field where talent is no longer hindered by the heavy investments required to start the business. Every aspirant, irrespective of the scale and size of their company, can compete in the textile sector and offer their creativity to buyers. This democratisation means more freedom of choice and deeper connections between stakeholders of the industry, which is critically important for the long-term growth of the sector. 



Name.....	Page
AVENER Capital	16
BIDSO	36
Buyofuel	42
DZONE Technologies	Back Inside
ELGi	32
Euro Panel Products Limited	15
Event Brigade	35
Phillips Machine Tools India Pvt Ltd	Back Cover
Raptee.HV	46
Schmalz India Pvt Ltd	Front Inside
STUDER	04
True Colors Limited	50
Vijayan Trishul Defence Solutions (VTDS).....	10



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

Copyright/Reprinting

Machine Edge Global and its publishing company hold all rights to the content, including publishing, distribution, and usage. Reprinting, duplication, or online publication of any magazine content is strictly prohibited without prior written permission. While every effort is made to ensure accuracy, Machine Edge Global assumes no responsibility for unintended errors. The publishing company and editorial team are not liable for unsolicited manuscripts, photographs, or illustrations submitted for consideration. Unauthorized reproduction or distribution may result in legal action. All rights reserved.



www.machineedgeglobal.com

Is your competitor getting better mileage

AUTOMOTIVE FIELD TRIALS
Conventional & Electric Vehicles: 2W, 3W, 4W, Commercial

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

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

