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From Factory Floors to Smart Ecosystems: Manufacturing's New Era

As global manufacturing enters a new phase defined not just by scale, but by intelligence, resilience, and adaptability, the role of industry leaders and emerging technologies has never been more critical. The March edition of Machine Edge Global brings into focus the strategic shifts shaping the future of manufacturing—from boardroom decisions that influence global expansion to technological advancements redefining efficiency on the shop floor.

On the cover, we feature an insightful conversation with Jörg Buchheim, Chairman of the Management Board and CEO of Webasto SE, who shares a compelling perspective on the company's growing commitment to India. As global manufacturers increasingly look toward India as both a market and an innovation hub, Webasto's strategy stands out. From expanding its manufacturing footprint and accelerating localization to positioning India as a global competence center for engineering excellence and roof innovations such as MagicSky, Buchheim outlines a vision where India is not just part of the journey—but central to the company's next phase of global growth.

This edition also explores critical decision-making areas for the built environment with our article on 5 Things Developers Must Consider Before Finalising Facade Materials in 2026. As sustainability, performance, and aesthetics converge, façade selection is becoming a strategic choice rather than a purely architectural one.

Equally transformative is the shift underway within factory operations. In Why the Next Wave of Manufacturing Efficiency Will Come From AI Agents, Not Automation, we examine how the industry is moving beyond traditional automation. While robotics and control systems have long driven productivity, the future lies in systems that can make decisions, adapt in real time, and optimize entire processes—not just individual tasks.

Energy and policy also take center stage in What Global Biofuel Policies Reveal About India's Next Moves. As nations recalibrate their energy strategies, biofuels are emerging as a cornerstone of sustainable growth. For India, global trends provide both a roadmap and a set of signals that could shape its regulatory and market direction in the years ahead.

Rounding out the edition is our deep dive into How AI Is Becoming the Backbone of Smart Factories with Automated Anomaly Detection. As manufacturing systems grow more complex, the ability to detect, predict, and respond to anomalies in real time is proving to be a game-changer—enhancing uptime, quality, and overall operational intelligence.

As always, Machine Edge Global remains committed to bringing you perspectives that matter—stories that not only inform but also challenge the way we think about manufacturing's future. In a world where change is constant, staying ahead requires more than awareness; it demands insight, foresight, and the willingness to evolve. We hope this edition equips you with exactly that.

Sanjay Jadhav

Sanjay Jadhav
Founder & Editor
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"India Will Remain One of Our Most Important Growth Markets"

– Jörg Buchheim

As India rapidly transforms into one of the world's most dynamic automotive markets, global suppliers are recalibrating their strategies to align with the country's scale, speed, and shifting consumer expectations. In this detailed conversation with **Sanjay Jadhav, Editor, Machine Edge Global** engages with **Jörg Buchheim, Chairman of the Management Board and CEO of Webasto SE,** to understand how the company is deepening its India commitment. From expanding manufacturing capacity and accelerating localization to positioning India as a global competence center for engineering and roof innovations like MagicSky, Buchheim explains why the country is set to play a defining role in Webasto's next phase of global growth.

Q. How does Webasto view India's importance in its global growth strategy, and what factors make the country a long-term strategic market for the Group?

India plays a pivotal role in our global growth strategy. The country is one of the world's fastestexpanding automotive markets and shows exceptional momentum in the adoption of sunroofs across virtually all vehicle segments. This strong demand reflects a clear shift in consumer expectations: Indian customers are increasingly looking for advanced comfort, premium design, and distinctive features that elevate their incabin experience.

At the same time, India is a highly dynamic technology hub. For Webasto, it is a key market to scale and industrialize roof innovations like "MagicSky"*. The longterm market outlook in India aligns perfectly with our strategic focus on innovative roof systems and future mobility solutions.

Beyond market growth, India represents a long-term strategic commitment for Webasto: we continue to expand our local-for-local strategy, strengthen our engineering capabilities, and build deep partnerships with leading OEMs. India will remain one of our most important growth markets.

*MagicSky is an innovative ambient light feature integrated directly into the vehicle roof. By combining advanced LED lighting with optical coupling technologies, MagicSky transforms the glass surface into a customizable light element. At night, the system creates dynamic lighting patterns with adjustable intensity, allowing drivers and passengers to personalize the interior ambiance. During the day, the transparent print remains virtually invisible, ensuring a clear and unobstructed view of the sky. The result is a distinctive lighting experience that enhances both comfort and aesthetic appeal without compromising the sunroof's primary function.

Q. Webasto has consistently spoken about its long-term commitment to India. How does this commitment translate beyond manufacturing into areas such as innovation, talent development, and partnerships?

Our commitment to India goes far beyond expanding our manufacturing footprint. India has become an integral pillar of Webasto's global development ecosystem and we are consistently strengthening this role in a very deliberate way with continued investments.

We are expanding our local engineering and R&D capabilities. Today, more than 200 engineers in India contribute not only to the needs of the local market but also to global development programs. Their work is essential for scaling advanced technologies.

Our teams develop solutions that are specifically tailored to local usage patterns, climate conditions, and customer expectations. This proximity to the market enables us to translate consumer insights into product features faster and more effectively than ever before. With our third plant in North India, we are not only expanding capacity but also reaffirming our intention to grow together with the Indian market for decades to come.

Q. India has witnessed a sharp rise in demand for sunroofs across vehicle segments. What is driving this trend, and how is Webasto positioning itself to cater to this growing demand?

The surge in sunroof demand in India is driven by a fundamental shift in customer expectations. Sunroofs have become a strong differentiation feature across all vehicle segments and are no longer limited to premium models. Indian consumers value the emotional and aesthetic value a sunroof brings: more natural light, more openness, and a clear upgrade in the incabin experience. For many customers, it has become a lifestyle choice rather than a purely functional one.

Webasto anticipated this development early, and we are positioning ourselves accordingly. With our third manufacturing facility in the Delhi region, which will start production at the end of 2026, we are now present in all major automotive

> *Looking ahead, Webasto India is set to become a global competence center for electronics and mechanical design. This means that Indian engineering resources will increasingly support major global projects.*

clusters. North, West, and South India. This significantly shortens supply routes, strengthens our localforlocal strategy, and enables us to serve our OEM partners with the speed and reliability they expect.

Q. Could you elaborate on Webasto's approach to localization in India? How critical is localized production in ensuring competitiveness, quality, and faster time-to-market?

To operate successfully here and elsewhere in the world, you need to be close to customers in a geographically, operationally, and technologically sense.

Localization almost covers the entire value chain. We work intensively with Indian technology partners in areas such as glass, motors, and ECUs to strengthen our local-for-local capabilities. This approach significantly reduces lead times, increases cost competitiveness, and

enhances supplychain resilience. At the same time, India-based production fully aligned with Webasto's global quality standards and processes.

Q. What kind of investments is Webasto making to strengthen its local production capabilities in India, and how do these investments align with the company's global manufacturing roadmap?

The most visible step is the new manufacturing facility in the Delhi region, which expands our footprint across all three major automotive clusters in India. With this site, our total local capacity moves toward roughly two million units per year, giving us the scale and flexibility required for a rapidly growing market.

These investments are not limited to increasing volume. They are designed to support both current and future OEM programs, including global customer platforms. India offers the ideal balance of market momentum, engineering talent, and industrial competitiveness – which makes it the right place to expand our capabilities in a structured and sustainable way.

Q. Webasto has been expanding its R&D footprint in India. What role does India play in the Group's global innovation ecosystem?

Our Indian R&D teams are an important innovation hub for cost-optimized, scalable solutions and already play an active role in global development and engineering programs. They support crossregional projects, accelerate development cycles and contribute to digital tools, testing methodologies and product optimization that benefit the entire Group.

Looking ahead, Webasto India is set to become a global competence center for electronics and mechanical design. This means that Indian engineering resources will increasingly support major global projects. The breadth of capabilities we are building covers design, simulation, testing and validation, which allows the teams to take on more endtoend responsibilities.

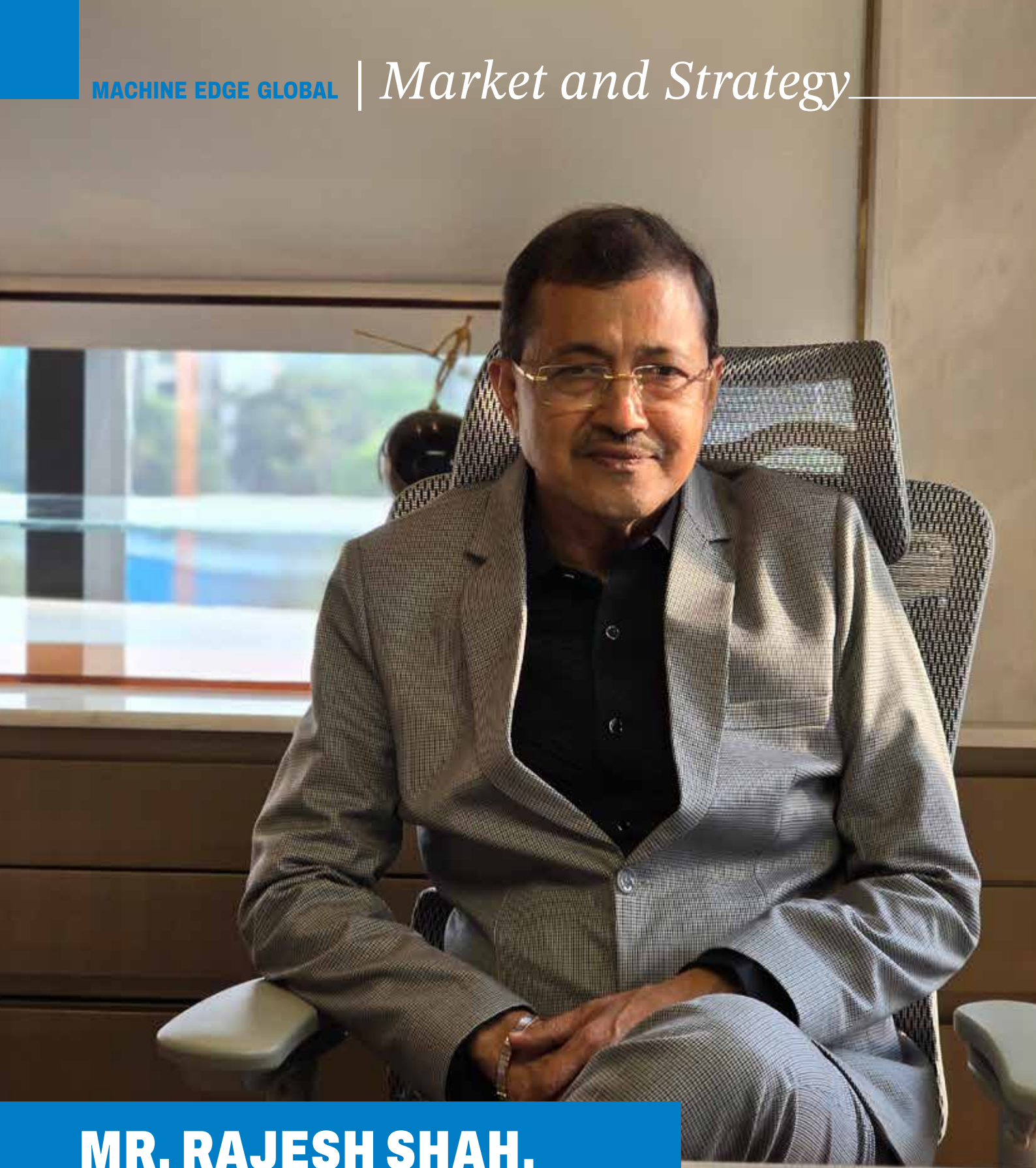
Q. How is India contributing not just as a manufacturing base but also as an innovation hub supporting global Webasto projects?

India has evolved into an important innovation pillar for Webasto. It adds engineering depth, speed and technological capability that directly benefit our customers. Our colleagues are also becoming more deeply involved in crossregional and crossfunctional innovation initiatives. Whether we are industrializing roof technologies or piloting digital process tools, our Indian teams bring strong technical expertise and a high degree of agility. This makes India an increasingly important part of our global innovation ecosystem.

Q. Finally, what is your outlook for Webasto in India over the next five to ten years, and what milestones should stakeholders look forward to?

With our new plant in the Delhi region and the strong trajectory of our existing Pune and Chennai facilities, Webasto will strengthen its

role as a highcapacity, highquality production. At the same time, our R&D capabilities will continue to grow. We also see deeper collaboration with our Indian OEM partners on new roof systems and advanced technologies. India is a market where innovation is accelerating quickly, and together with our partners we will bring new concepts into series production. Most importantly, our longterm outlook for India is defined by continuous investment in people, in technology, in sustainability and in customer relationships.



MR. RAJESH SHAH,

MD OF EURO PANEL PRODUCTS LIMITED

5 Things Developers Must Consider Before Finalising Facade Materials in 2026

The era of the aesthetics-first facade is over. While cladding selection was historically driven by visual appeal and upfront cost, tightening regulations now dictate that performance comes first.

A modern facade is a building's primary defense against fire, wind loads, and environmental degradation. Consequently, developers must execute rigorous due diligence into a material's composition, manufacturing origin, and certified safety. Here are the five non-negotiable pillars driving facade selection in 2026.

Warranty of the Material

Developers must demand coverage that precisely aligns with an asset's true lifecycle—scaling up to 15 or 20 years for premium infrastructure. However, a paper guarantee is meaningless if the issuer lacks credibility. A warranty alone offers no real protection without the manufacturer's financial stability and technical capability to honor it. When inferior materials inevitably fail, developers are left exposed to compounding replacement costs, compliance liabilities, and severe brand damage.

The new standard is non-negotiable: materials must be tested, certified by an authorised government body, and then warranted. Furthermore, trust must be replaced by verification. Industry leaders mandate that performance claims be backed by NABL-accredited (ISO/IEC 17025) in-house labs. When a manufacturer internally verifies 16 different parameters like impact resistance and coating thickness, the warranty transitions from a marketing promise to a documented, scientific fact.

Durability of Material

While standard commercial-grade alloys have historically been the norm, they can pose unnecessary structural risks over time. For superior architectural strength, a more prudent approach involves specifying high-performance options like the 3003 and 5000 series. The 5000 series (such as 5005) serves as a true marine-grade solution, making it the ideal recommendation for coastal infrastructure. Engineered for targeted corrosion resistance and a higher strength-to-weight ratio, these advanced alloys help ensure panel flatness and long-term structural integrity under severe thermal stress

This requirement has driven the adoption of the Engineered Solid Panel.

- For those developers that are working in high-risk areas where fire safety is critical, developers are choosing Solid-Aluminum Panels as these panels are made of a homogeneous metal and, consequently, achieve the highest Class A1 rating for non-combustibility.
- For projects that require versatility in terms of design and exterior appearance, Engineered Solid Panels can be specified to have Class A2 fire-retardant characteristics, while allowing for dual finish options (i.e. two different finishes applied to the same side of the panel)

Advanced panel coatings like PVDF (Polyvinylidene Fluoride) and FEVE coatings, are engineered to resist the fading and chalking that plague standard polyesters.

Test Certificate & The Issuing Body

As fire safety norms become universally stricter, a generic, self attested report is no longer sufficient. True risk mitigation requires a definitive, uninterrupted chain of custody from internationally accredited testing authorities.

Developers must demand project-specific certifications from international third-party testing and certification labs like Thomas Bell-Wright, TUV Nord, or Exova Warringtonfire. Crucially, internal due diligence must verify that the provided certificate matches the exact batch and technical specifications of the material delivered to the site.

Equally critical is validation through NABL-accredited (ISO/IEC 17025) facilities, a highly desired benchmark that demands strict equipment calibration, verified staff competence, and grueling unannounced audits. Backed by global Mutual Recognition Arrangements (MRA), this rigorous accreditation ensures that a manufacturer's everyday production holds the exact same weight and reliability as international safety standards.

Service & Delivery Part

The logistics crisis of the early 2020s taught the construction world a hard lesson: a superior product is useless if it is stuck in a container halfway across the world.

This realization has driven a preference for backward integration. Manufacturers who have moved from simple assembly to full-scale engineering—bringing continuous coil coating and paint mixing processes in-house—have effectively protected themselves against global supply chain volatility. This domestic capability doesn't just mean faster delivery; it allows for the customization of cores like fire-retardants among others as well as specific finishes in a fraction of the time it takes to import, keeping project timelines strictly on track.

Long-term Durability & Weather Performance

In the end, the message is one of accountability. As climate change accelerates the frequency and severity of extreme weather events, true

weather performance is no longer a theoretical promise; it is validated through grueling, quantifiable metrics. Modern architecture demands materials proven to withstand extreme environments—verified through 1,000-hour Accelerated Weathering, Salt-Spray, and Humidity resistance tests mimicking real world environments. Furthermore, evaluating parameters like Linear Thermal Expansion, Abrasion Resistance (Falling Sand), and 1,000-hour Colour and Chalk Retention ensures the facade will not warp, delaminate, or degrade under severe thermal stress and intense UV exposure.

Beyond physical durability, sustainability will be quantifiable in ways that can be measured. Examples will be Zero Liquid Discharge (ZLD) manufacturing for facilities and the use of renewable energy, solar, to operate their production lines. Examples will be making a commitment to the circular economy through 100% recyclable aluminium cladding that maintains its structural integrity.

Ultimately, choosing a facade material has a lasting impact for the next several years. By promoting building materials that are sustainable and durable that meet or exceed verified safety criteria, developers are not just finishing a building; they are also creating a future-proof asset.

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Why the Next Wave of Manufacturing Efficiency Will Come From **AI Agents, Not Automation**

For decades, manufacturing's efficiency gains have been driven by automation, faster conveyors, robotic arms, and scripted control logic that replace manual tasks. Those advances delivered predictable improvements in throughput, consistency, and safety. But they also left a gap. Automation optimizes tasks, it rarely optimizes decisions. Today's factories don't just need faster machines, they need smarter coordination, contextual judgment, and continuous learning. That is where AI agents enter the picture.

An AI agent is not a faster script. It is a decision-capable software system that perceives context, plans actions, acts across systems, and learns from outcomes. Unlike classical automation that executes pre-defined rules, agents can reason across heterogeneous data, call APIs, consult human experts when needed, and adjust behavior when conditions change. For manufacturing, that shift, from mechanizing actions to automating decisions, redefines what efficiency means.

Consider maintenance. Predictive maintenance uses models to forecast failures, it is valuable but limited when it cannot act autonomously across the broader production environment. An AI agent, by contrast, can combine

sensor data, inventory status, supplier lead times, and production schedules to decide whether to schedule a maintenance window now, shift workload to another line, or order parts from an alternate vendor. It can negotiate trade-offs, accept slightly higher short-term risk to avoid a major production halt, or escalate to a human with a concise rationale and recommended actions. That is not mere automation; it is decision orchestration, and the productivity gains are systemic rather than local.

The same pattern applies to quality. Traditional automation inspects and rejects. An AI agent integrates vision feeds with historical defect patterns, operator notes, and upstream process parameters, then identifies root causes, suggests process adjustments,

and triggers corrective workflows. It can prioritize containment actions based on impact, route defective items appropriately, and update inspection thresholds dynamically. The result is fewer false positives, faster problem resolution, and improved yield, benefits that compound across lines and plants.

Why do agents outperform automation in real-world manufacturing? The answer is threefold. First, agents handle complexity. Modern factories are socio-technical systems: machines, humans, suppliers, legacy IT, and cloud analytics all interacting. Agents reason across those layers. Second, agents adapt. They learn from outcomes and adjust policies, reducing the brittleness that plagues static automation. Third, agents act as orchestrators; they are glue that connects predictive insights to operational execution, turning intelligence into measurable action.

Transitioning to agentic systems requires a fundamentally different architecture than traditional automation. The data foundation must be unified and governed, models only perform when fed consistent, timely, and trusted inputs. The control layer must support secure connectors to

MES, ERP, SCADA, and cloud services while preserving auditability. And the governance layer must define decision rights, human-in-the-loop thresholds, and fail-safe fallbacks. In short, agentic manufacturing requires a platform approach, one that treats AI, data, and operations as integrated infrastructure, not point projects.

There is also an operational playbook. Start with high-value, bounded tasks where agents can augment human decision-making: maintenance scheduling, quality triage, line changeovers, and supplier exception handling. Use agents to automate the decision "front-end" while keeping humans in the loop for governance and rare exceptions. Measure outcomes not by tasks automated but by decision cycle time, mean time to resolution, yield uplift, and cross-functional coordination metrics. Success here builds confidence to expand agents into broader orchestration roles.

The economic case is compelling when measured properly. Automation often promises per-task cost reductions. Agents promise systemic reductions in downtime, inventory carrying, and scrap, while increasing throughput and responsiveness. For example, a line that previously lost hours to manual triage can recover production capacity when an agent reduces the time to identify and fix root causes. Those recovered hours compound across lines and shifts. When agents coordinate supply responses, they convert inventory into working capital and reduce expedited freight costs. This is how agentic systems unlock ROI that traditional automation seldom reaches.

Yet this future is not without risks. Agents amplify both value and exposure. An agent making high-impact decisions needs transparency: explainable recommendations, auditable logs, and clear rollback procedures. Data quality issues or drift can create cascade effects. A governance-first approach mitigates these risks. Design agents with conservative escalation rules, simulate behavior extensively in shadow mode, and define clear ownership and accountability before going live. In our experience, the fastest route to safe scale is not to bypass governance, it is to bake it into the agent lifecycle from design to decommissioning.

People change matters, too. Operators and engineers must trust agents. That trust is built when agents provide concise explanations, when humans can easily override decisions, and when the system demonstrates measurable improvements. Training and change programs should be practical: hands-on pilot deployments, joint agent-human workflows, and rapid feedback loops that capture operator insights and improve agent behavior. Agents should be collaborators, not black boxes imposed on the floor.

Finally, the strategic winners will be those that view agents as an enterprise capability. Siloed pilots create silos of intelligence. The value of agents multiplies when they share a common platform, re-usable connectors, shared knowledge graphs, and centralized governance. This is why manufacturing leaders should invest in CoEs and platforms that can steward agent development, monitor performance, and ensure compliance across sites and geographies.

The next wave of manufacturing efficiency will not be a single technology; it will be a new operating model. Agentic AI converts isolated intelligence into coordinated action. It moves factories from reactive optimization to proactive orchestration. For leaders facing rising complexity, volatile supply chains, and demand for higher quality at lower cost, agents offer a pragmatic path to competitive advantage.

Investing in agentic systems is not abandoning automation. It is elevating it. The robots will keep running the lines; agents will decide how the lines best run, when to stop, when to reassign, when to adapt. That distinction matters. As manufacturing evolves, those who choose decision intelligence over mere task automation will not just be faster, they will be smarter, more resilient, and measurably more efficient.

What Global Biofuel Policies Reveal About India's Next Moves

KISHAN KARUNAKARAN,
Founder & CEO Buyofuel

The global biofuel sector has moved far beyond its early experimental phase. What was once considered an auxiliary component of the energy mix is now central to national strategies for energy security, emissions reduction, and rural economic development. For India — a rapidly growing economy with rising fuel demand and ambitious climate goals — global biofuel policies offer valuable signals about the likely trajectory of its own regulatory and market evolution.

A review of international biofuel frameworks reveals several recurring policy patterns: long-term regulatory certainty, increasing focus on advanced and waste-based fuels, integration with carbon accounting systems, and sector-specific deployment strategies. These trends provide meaningful insight into how India's biofuel landscape may evolve in the coming years.

Policy Certainty as the Foundation of Growth

One of the clearest lessons from mature biofuel markets is the importance of stable, predictable policy environments. In the United States, the Renewable Fuel Standard (RFS) created multi-year demand visibility, allowing producers, refiners, and investors to plan capacity expansion with confidence. Similarly, the European Union's Renewable Energy Directive (RED) established structured renewable targets that tied biofuel adoption to decarbonization objectives.

For India, the success of the ethanol blending program demonstrates the power of policy clarity. The acceleration toward E20 blending targets significantly reshaped investment behavior across distilleries, supply chains, and feedstock procurement systems. Global experience suggests that India's next policy steps may involve extending similar certainty to other fuels — particularly biodiesel, sustainable aviation fuel (SAF), and compressed biogas (CBG). Long-term visibility reduces financing risk, attracts institutional capital, and strengthens ecosystem development.

The Global Shift Toward Feedstock Diversification

Early biofuel policies were heavily reliant on food-based crops, often triggering concerns about food security and land use. Over time, regulators increasingly favored non-food and waste-based feedstocks. Brazil's investments in second-generation ethanol from agricultural residues and the EU's emphasis on waste-derived biofuels illustrate this transition.

India's structural advantages align well with this global shift. The country possesses abundant underutilized resources: agricultural residues, used cooking oil (UCO), municipal solid waste, and industrial by-products. Policies that incentivize these feedstocks reduce import dependence while avoiding food-fuel conflicts. As sustainability scrutiny intensifies globally, India is likely to deepen traceability mechanisms, certification frameworks, and differentiated incentives for advanced biofuels.

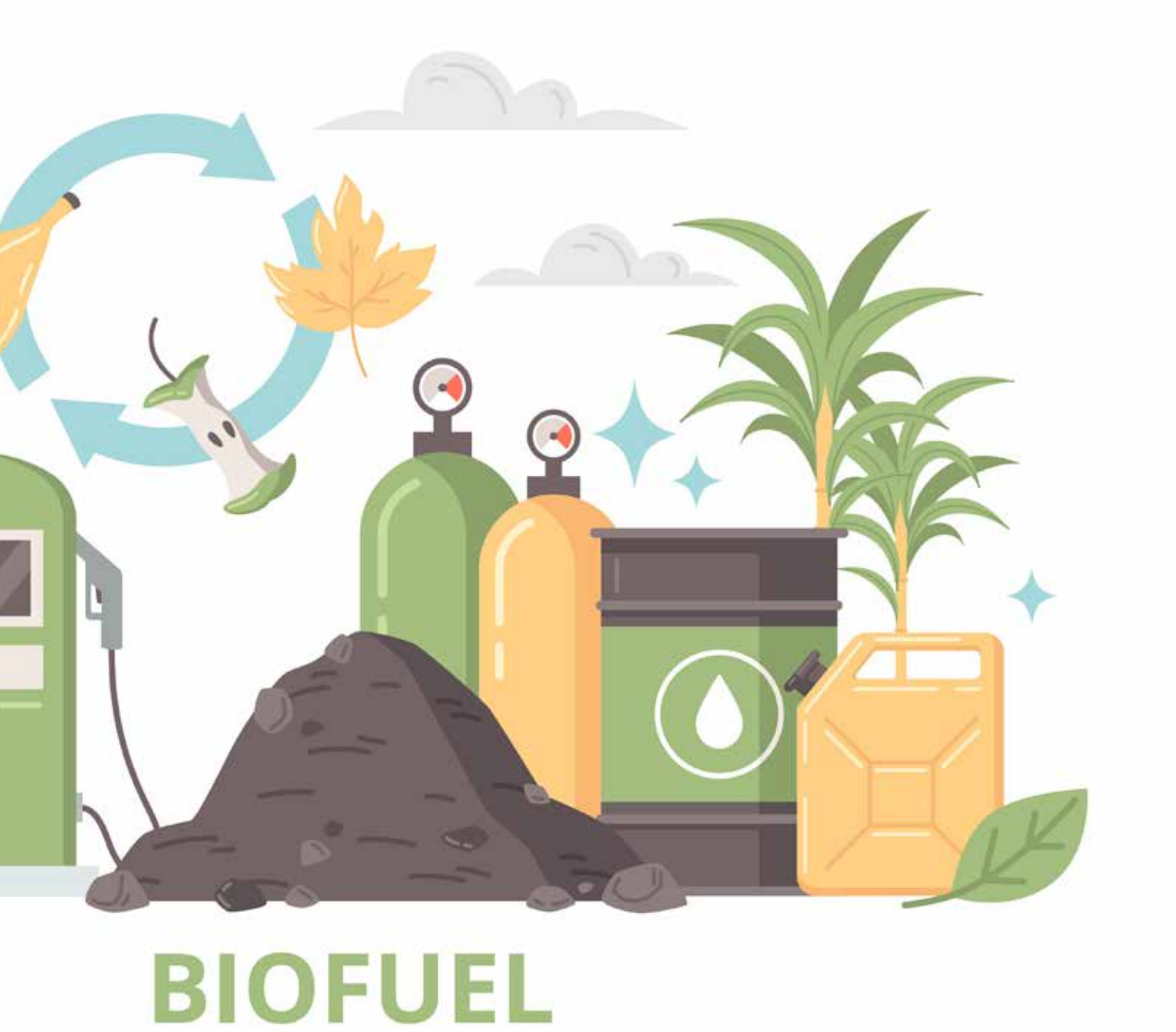
Carbon Intensity Is Redefining Biofuel Policy

Globally, biofuel regulation is increasingly anchored in lifecycle emissions rather than simple blending volumes. Programs such as California's Low Carbon Fuel Standard (LCFS) reward fuels based on carbon intensity, thereby encouraging technological innovation and low-emission pathways.

India's emerging carbon market architecture may eventually influence biofuel policy design in a similar manner. A gradual shift toward emissions-based incentives could unlock new value pools, particularly for advanced biofuels and decentralized production systems capable of demonstrating superior environmental performance. This transition would align biofuel growth directly with national climate commitments rather than treating it as a standalone fuel-substitution strategy.

Sector-Specific Deployment Is Becoming the Norm

Internationally, biofuels are no longer viewed as universal substitutes but as targeted solutions. Aviation



policies emphasize SAF blending mandates, heavy-transport strategies prioritize renewable diesel and biogas, and maritime sectors explore bio-methanol and alternative fuels.

India may increasingly adopt a comparable sectoral approach. Ethanol primarily supports gasoline substitution, while biodiesel, CBG, and SAF could address freight, industrial energy use, and aviation decarbonization. Sector-specific policies improve efficiency, optimize feedstock utilization, and accelerate technology adoption where electrification or hydrogen pathways face constraints.

Domestic Priorities Will Shape Policy Direction

Despite global parallels, biofuel policies ultimately reflect national contexts. The United States leveraged surplus corn production; Brazil capitalized on sugarcane productivity; Europe prioritized waste streams due to land limitations. India's policy framework will similarly be driven by domestic imperatives: energy security, rural income stability, waste management challenges, and air-quality objectives.

Biofuel policies that address multiple priorities simultaneously are more likely to achieve durability and scale. Waste-to-fuel pathways, for instance, can support circular-economy goals, reduce environmental pollution, and strengthen local economic activity.

India's Likely Strategic Next Moves

Global policy patterns indicate that India's future biofuel strategy may involve:

- Extending long-term blending certainty across fuel categories
- Accelerating advanced and waste-based biofuel adoption
- Embedding lifecycle carbon accounting into incentive structures
- Designing sector-specific mandates and market mechanisms
- Strengthening sustainability and traceability systems

Rather than copying foreign models, India appears positioned to adapt global lessons to its unique economic and resource conditions. The broader direction is unmistakable: biofuels are transitioning from alternatives to essential components of modern energy systems.

In this evolving landscape, policy design — more than technological availability — will determine how rapidly India scales its biofuel ambitions and captures associated economic and environmental benefits.

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How AI Is Becoming the Backbone of Smart Factories with Automated Anomaly Detection

The digitalisation of manufacturing means modern factories are more complex than ever, with thousands of connected sensors generating continuous streams of data. While humans have historically relied on manual data inspection, it is now more challenging than ever for operational leaders to detect anomalies before issues arise

RACHEL JOHNSON,
Principal Product Manager, MathWorks

Manufacturing leaders are therefore looking for smarter systems that can predict problems before they happen to ensure smooth operations with fewer disruptions. A 2025 Deloitte study found that 86% of manufacturing executives think smart factory solutions will be the primary drivers of competitiveness over the next five years.

Incorporating AI into manufacturing is a strategic necessity. A growing number of engineers, armed with a deep understanding of the systems they design and operate, are turning to AI-based anomaly detection solutions.

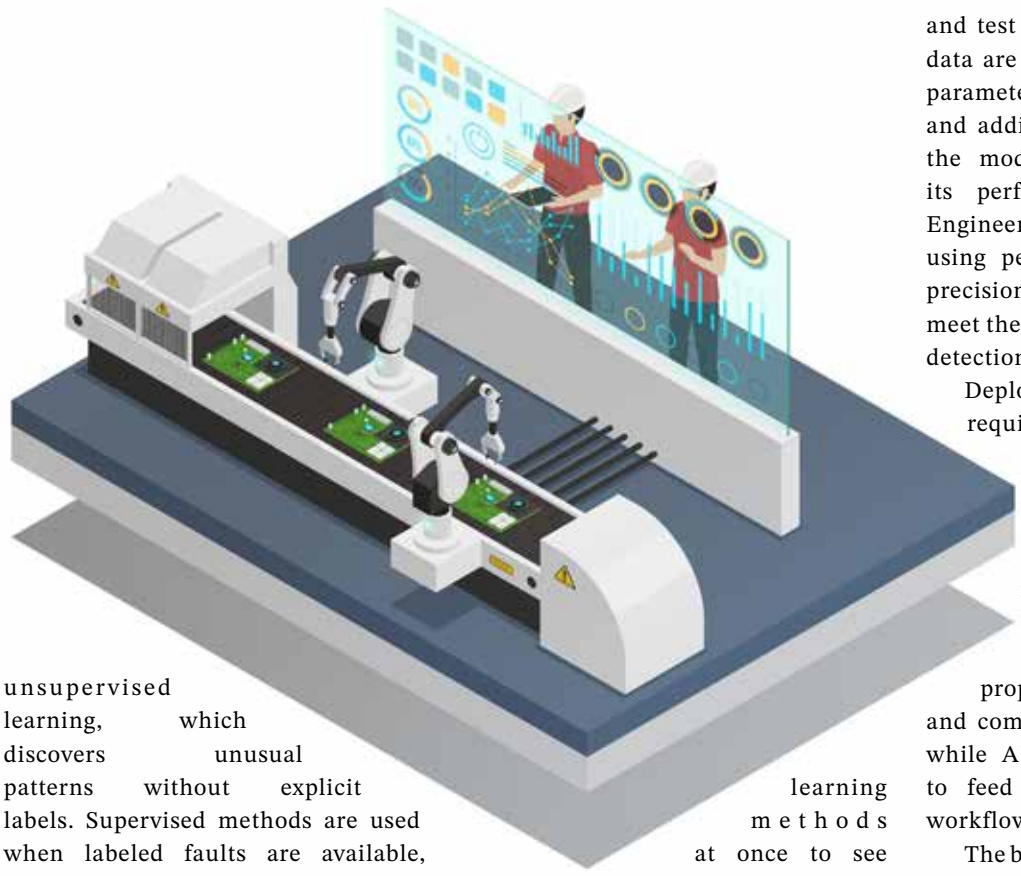
Most leaders are in sync with this shift, reflected in projections that the global AI-in-manufacturing market is will reach $34.1 billion in 2030 at a compound annual growth rate (CAGR) of 42.1% . Meanwhile, another study shows AI use across industries stood at 48% in India in FY2024, with manufacturing alone rising from 8% to 22% in just one year.

How AI works for Anomaly Detection

Integrating AI into manufacturing processes may be complex, but the potential rewards in terms of efficiency, cost savings, and competitive advantage are immense. Firstly, for organisations new to AI, the first stepis to define what constitutes an anomaly. For example, BMW engineers realized they needed to distinguish between a true defect (a crack or missing part) and a pseudo-defect (harmless dust). Identifying the issue and determining the solution resulted in a 60% reduction in defects and led to cost savings of over $1 million per year at their Spartanburg plant.

The next step involves data gathering and preparation. AI effectiveness depends almost entirely on the quality of incoming data. Sensor readings, environmental conditions, maintenance logs and operational parameters must be collected, cleaned, and structured for analysis. This stage often requires as much effort as the modelling itself. Flawed or incomplete data will undermine any AI system's effectiveness.

Once data is adequately prepared, engineers must decide which AI techniques to apply. Broadly, they must choose between supervised learning, where labeled examples of normal and anomalous behaviour exist, and



unsupervised learning, which discovers unusual patterns without explicit labels. Supervised methods are used when labeled faults are available, while unsupervised approaches are effective where anomalies are rare or not collected.

Feature Engineering and Advanced Techniques

AI models are only as good as the data they learn from. Feature engineering is the process of extracting useful quantities from raw data, which can help AI models learn more efficiently from the underlying patterns. While experienced engineers often already know the types of features that are important to extract from the sensor data, Predictive Maintenance Toolbox™ in MATLAB provides interactive tools for extracting and ranking the most relevant features in a dataset to enhance the performance of supervised or unsupervised AI models.

Tools like the Classification Learner in MATLAB® help engineers experiment with multiple machine learning methods at once to see which model performs best, as Mondi Gronau did to predict potential failures in plastics manufacturing machines. The trained model can predict whether a new chunk of sensor data is normal or anomalous.

Some types of data, such as images or text, benefit from deep learning approaches that can extract patterns automatically without requiring explicit feature extraction. Combining time series and image-based anomaly detection has helped some companies to identify faults in underground power cables using deep learning. While these deep learning approaches are powerful, they also require larger training datasets and computational resources.Validation, Testing and Deployment

Before an AI model can be used in operation, it must be validated and tested. Engineers usually split the data into three parts: training, validation, and test sets. Training and validation data are first used to align the model parameters during the training phase, and additional test data is used after the model is trained to determine its performance on unseen data. Engineers also evaluate the model using performance metrics, such as precision and recall, and fine-tune to meet the needs of the specific anomaly detection problem.

Deploying AI into live operations requires precise planning. Decisions around where models run depend on factors like latency, computational needs and integration requirements. Well-designed pipelines ensure that incoming data is properly formatted, preprocessed, and communicated to the AI system, while APIs allow model predictions to feed directly into maintenance, workflows, and decision systems.

The benefits of AI-enabled anomaly detection in smart factories extend well beyond early problem detection. According to a Deloitte Survey, the value of smart manufacturing has been realized, with respondents reporting up to 20% improvement in production output, 20% in employee productivity, and 15% in unlocked capacity.

Ford leveraged AI-driven digital twins to streamline vehicle manufacturing. Virtual replicas of its models allow the company to track and optimise production across design, assembly, and factory operations, while also informing improvements in efficiency and customer experience.

Manufacturers are reporting measurable improvements in uptime, reduced maintenance costs, fewer defects, and higher throughput. AI is no longer just an enabler of competitive edge for a select few companies; it's becoming the backbone of smart factories across the manufacturing sector.

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How Supply Chain Analytics Is Powering the Next Wave of Smart Manufacturing

While the world grapples with unprecedented volatility, uncertainty, complexity, and ambiguity on an almost daily basis, the boundary between the factory floor and the global logistics network has effectively vanished. In its place has emerged a layer of connected intelligence that positions supply chain analytics as the central nervous system of modern manufacturing. No longer relegated to back-office reporting, supply chain advanced analytics is now the primary engine driving the next wave of smart manufacturing, enabling a shift from passive observation to autonomous orchestration.

SARAVANA S. KUMAR,
Supply Chain Leader & Associate Partner at Tiger Analytics

To appreciate why this shift matters, lets reflet on a few scenarios that many manufacturing leaders have encountered, often more than once.

Scenario 1:

Imagine a large automotive OEM whose brand commands deep customer loyalty. Buyers are willing to wait longer and pay more for that familiar badge on the hood. One morning, however, a small yet critical branded component runs out of stock. The next batch is due in a week. That single missing item halts the assembly line, disrupts shipments, and triggers a cascade of alarms and urgent calls across the enterprise. Decades of manufacturing excellence are suddenly undermined by one overlooked dependency. The problem is not manufacturing capability, it is the absence of connected, predictive insight across the supply chain.

Scenario 2:

A procurement leader in a white goods manufacturing company has built a lean, efficient, and highly data-driven organization. Tier-1 suppliers share inventory positions, capacity, and shipment notifications seamlessly. Trust has been earned over years of collaboration. Yet somewhere beneath the surface lies a blind spot. Deep-tier suppliers—Tier-3, Tier-4, and beyond—are poorly mapped. The risk is known, acknowledged, and deprioritized. Then comes the call: a Tier-1 supplier warns of a short delay. Days later, the factory is facing a major material shortage. A fire at a Tier-4 supplier has disrupted the flow of materials. Deep-tier opacity, not poor execution, has caused the breakdown.

Scenario 3:

Elsewhere, leadership makes a strategic decision to reshore manufacturing from low-cost countries. The mandate is ambitious: build a factory of the future that is more productive, economical, reliable, and agile than offshore operations. Yet reality quickly sets in. Two decades of operational data are scattered across multiple systems, languages, and formats. Skills are uneven. Legacy processes persist. The challenge is not whether analytics and AI are required, but where to begin and how to scale with confidence.

Scenario 4:

The VP Manufacturing in a manufacturing organization has

been watching peers deploy control towers, digital twins, and AI-enabled transformation programs with apparent success. In his own company, however, complexity dominates. Recent acquisitions have created fragmented ERP landscapes. SKU proliferation has increased planning volatility. Modern MES deployments are underway while hundreds of heterogeneous sensors generate vast volumes of data. AI is part of her vision, but clarity on how to bring purpose and coherence to this data-rich yet chaotic environment remains elusive.

Each of these scenarios appears different on the surface, yet when companies are well on course of gaining control on these and other similar challenges, they are in the realm of 'Smart Manufacturing'. At the heart of this journey lies resiliency, a guiding principle whose paths are as varied as the ways it is defined. According to me, resiliency is the ability of an ecosystem to anticipate uncertainty, recognize emerging vulnerabilities, and respond decisively to restore performance with minimal cost and disruption.

However, each company has its own unique challenges to move ahead in this journey.

The solutions to these challenges increasingly reside across extended and deeply interconnected supply chains. By leveraging real-time IoT telemetry, AI-driven digital twins, and predictive risk modelling and many other such initiatives, manufacturers are evolving beyond traditional automation into self-optimizing ecosystems. This shift allows, data activation, where disruptions—ranging from a Tier-3 supplier delay to a sudden shift in customer demand—are not only detected early but mitigated proactively, often before they reach production.

This evolution is driven by the convergence of multiple forces. Industry 4.0 automation provides the foundation, while human-centric collaboration ensures adoption and trust. Agentic systems introduce autonomy, enabling intelligent decision-making at speed and scale. Sustainability increasingly shapes design and execution choices. Together, these elements define the 'Smart Factory of the future'.

At the core of this transformation is a robust data foundation that connects operational, enterprise, and external data sources. Rather than centralizing control, modern Data Hubs connect diverse OT, ET, and IT data sources into a unified foundation, providing scalable capabilities for data access, transformation, contextualization, and modeling. while decentralizing and promoting ownership of data to domains closest to data. Digital threads extend this capability across customers, suppliers, and third parties, creating a continuous flow of information thus makes AI-enabled decision-making possible.

As maturity increases, organizations move from Visibility to Autonomy. The transition from descriptive dashboards ("what happened") to agentic AI that can automatically reroute shipments or adjust production schedules in real-time.

Digital Twin Advantage uses virtual models to simulate scenarios to assess impacts and costs, allowing manufacturers to test resilience strategies without physical risk. At the same time, Bi-Directional Synchronization aligns shop-floor operations with external supply signals and customer side demand signals to eliminate 'waste' in the manufacturing

As agentic orchestration matures, coordination extends across Agents, Robots, and People working toward to achieve complex business goals, dynamic workflows, real-time adaption and intelligent automation at scale. Rapid insights generated by AI systems trained on years of operational history, manuals, test reports, Root Cause Analysis (RCA), Failure Modes & Effect Analysis (FMEA) etc to generate rapid and accurate insights to action enabling precise and timely action.

Ultimately, the most crucial factor in this journey is Data Analytics and AI culture. A sustained commitment to D&A across the organization as it adopts new ways of working.

There has never been a more critical moment to initiate or recalibrate the smart manufacturing journey.

Success in this transformation hinges on the ability to bring data, deep domain expertise, and AI together in a meaningful way. Taking a deliberate pause to assess the organization's data strategy, along with the availability, and reliability of that data. Just as important is cultivating a genuine appreciation for data and AI, starting from the leadership level and cascading across the enterprise. Operating models must evolve to embrace new, AI-enabled ways of working, while resisting the temptation to prioritize short-term wins over long-term capability building.

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Automation, EVs & Semiconductors: The New Drivers of Shop-Floor Hiring

As India's manufacturing sector enters a new phase of capacity-led expansion—spanning EVs, electronics, semiconductors, renewables, and advanced materials—the employment narrative is becoming more strategic and skill-centric. In this conversation, **Balasubramanian A, Senior Vice President at TeamLease Services,** speaks with **Machine Edge Global Editor Sanjay Jadhav** on how commissioning-linked hiring, rising automation, PLI-driven growth, Rare Earth Corridors, and improved export outlook are reshaping workforce demand. He outlines where the talent gaps are most visible, how wage trends are evolving on the shop floor, and why flexible staffing models are emerging as a critical lever in balancing agility with long-term workforce stability.

BALASUBRAMANIAN A,
Senior Vice President at
TeamLease Services,

Q. How would you assess the current employment outlook in India's manufacturing sector?

Unlike earlier cycles of aggressive headcount addition, workforce expansion is now closely aligned with production commissioning timelines and productivity benchmarks. Over the next few years, the sector is expected to generate 1.5–2 million incremental jobs, with hiring concentrated in industrial corridors such as Hosur, Chennai, Pune, Coimbatore, Sri City, Ahmedabad, and Hyderabad. Seasonal production cycles in automobiles, construction materials, appliances, and export-linked goods further create temporary spikes in frontline manufacturing deployment. Semiconductor projects across Gujarat, Assam and southern clusters are projected to generate ~1 million ecosystem jobs in 2026–28 (fabrication, ATMP, chip design, supply chain). National Manufacturing Mission aligning clean-tech, advanced materials, EV batteries and green hydrogen manufacturing under a unified industrial roadmap.

Also, Union Budget 2026–27 has announced Dedicated Rare Earth Corridors across Odisha, Kerala, Andhra Pradesh, and Tamil Nadu, alongside a ₹7,280 crore REPM Manufacturing Scheme to create 6,000 MTPA integrated capacity. This push is expected to generate jobs across mining, mineral processing, and advanced manufacturing, strengthening the clean-tech and electronics value chain.

India's recently concluded FTAs and improving trade access are strengthening export competitiveness for textile manufacturing. Additionally, the recent U.S. Supreme Court ruling quashing certain tariff measures has eased trade uncertainty, supporting order recovery from key export markets. Together, these developments are expected to accelerate capacity utilisation and drive incremental job creation across textile clusters.

Q. What types of roles are currently seeing steady demand across the manufacturing sector?

As new capacities are commissioned across automobiles, EVs, electronics, renewables, capital goods, and industrial components, hiring demand is rising across blue-collar shopfloor roles, including machine operators, assembly technicians, quality inspectors, maintenance staff, warehouse handlers, and line supervisors.

Q. How is the skills requirement in manufacturing evolving with increasing automation and digitisation on the shop floor?

Manufacturing employers are increasingly prioritising multi-skilling, commissioning-paced hiring, automation readiness, and compliance-driven workforce structures. Together, these trends position India's manufacturing ecosystem for sustained, skill-led blue-collar workforce expansion over the medium term, with productivity and adaptability emerging as the defining workforce differentiators.

Q. Are manufacturers today facing talent shortages in specific functions or geographies? If so, where is the gap most visible?

Manufacturers are facing targeted shortages in automation-integrated roles such as PLC/CNC technicians, robotics maintenance, and quality/compliance functions, especially in PLI-linked sectors. The gap is most visible in high-growth industrial corridors like Tamil Nadu, Maharashtra, Gujarat, and Telangana, where commissioning activity is high. The shortage is driven more by limited multi-skilled, digitally capable talent than by overall labour availability.

Q. How are wage trends shaping up in the manufacturing sector, particularly for shop-floor and mid-skill roles?

Compensation for blue-collar manufacturing roles has been rising gradually as employers compete for technically reliable and multi-skilled talent. Entry-level shopfloor roles typically offer annual compensation in the range of ₹1.8–₹3.2 lakh, depending on location, shift structure, automation exposure, and productivity-linked incentives.

Q. What role does contractual and flexible staffing play in manufacturing compared to permanent workforce expansion?

Contractual and flexible staffing plays a critical role in manufacturing by providing agility in a commissioning-paced and demand-sensitive environment. It enables companies to scale workforce deployment quickly during plant ramp-ups, seasonal production spikes, and export surges, while maintaining cost flexibility and managing high attrition in blue-collar roles. Contract staffing is typically used for shopfloor operators, assembly lines, warehouse and project-based roles, whereas permanent hiring is increasingly focused on multi-skilled

technicians, automation engineers, and supervisory positions that drive productivity and compliance. Together, flexible and permanent workforce models help manufacturers balance agility with long-term operational stability.

Q. Which manufacturing segments are currently driving the strongest demand for frontline and shop-floor staffing?

Electronics and EV segments are expanding rapidly under PLI-linked capacity additions, creating high demand for assembly technicians, machine operators, quality inspectors, and line supervisors. Automotive and auto-component clusters continue to require flexible shopfloor deployment aligned with production cycles. Meanwhile, capital goods, industrial components, and construction materials are seeing steady demand due to infrastructure expansion and domestic consumption. Together, these segments are sustaining consistent blue-collar hiring momentum across major industrial corridors.

Q. How are staffing firms like TeamLease helping manufacturers balance rapid hiring with skill readiness amid tight labour markets?

Staffing firms like TeamLease help manufacturers balance rapid hiring with skill readiness by combining fast deployment with structured compliance and skilling support. They maintain pre-screened talent pools across industrial corridors to enable quick onboarding during commissioning or demand spikes, while managing payroll and statutory compliance seamlessly. At the same time, modular upskilling and cross-skilling programs help convert frontline workers into multi-skilled, automation-ready technicians, ensuring productivity alongside workforce agility.

Q. How does rising capacity utilisation in manufacturing signal an impending manpower inflection point for employers?

Rising capacity utilisation indicates that factories are nearing optimal output levels, where further demand cannot be met through efficiency gains alone. As production lines run fuller and shift intensity increases, employers typically need to add frontline and supervisory manpower to sustain output, prevent downtime, and support new line commissioning. It often signals an upcoming, calibrated workforce expansion phase.

Q. How can policy support, skilling initiatives and flexible staffing models help manufacturers convert this optimism into long-term job creation?

Policy support creates investment confidence and capacity expansion, skilling initiatives ensure workers are automation-ready and productivity-aligned, and flexible staffing models provide the agility to scale efficiently. Together, these elements help manufacturers translate growth momentum into sustainable, long-term job creation.

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