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MACHINE EDGE GLOBAL

Navigating the Cutting Edge of Industry News

MARKET AND STRATEGY
Peppermint Robotics

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Managing Director of Mitsubishi Electric India

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CSR with Purpose: How Indian Companies Are Building a Better Tomorrow

As India's industrial and economic landscape evolves, so too does the understanding of corporate responsibility. Today, we are witnessing a powerful shift—where Indian businesses are moving beyond profit-focused agendas to become agents of social transformation. Corporate Social Responsibility (CSR) in India is no longer a checkbox activity; it is a strategic commitment to national development.

From rural empowerment and healthcare to education and environmental stewardship, Indian companies are adopting innovative CSR models that address real societal challenges. These initiatives reflect not only compliance with regulatory mandates but also a deeper sense of purpose and community impact. The most successful CSR programs today are defined by transparency, strategic alignment with core values, and a focus on measurable outcomes.

Our July cover story highlights one such exemplary effort—Mitsubishi Electric India, which is setting benchmarks through its focused CSR approach. The company's initiatives around urban lake conservation and rejuvenation in Talegaon and Pimpri Chinchwad stand out as timely interventions in areas increasingly burdened by urban stress. These projects exemplify how engineering-driven companies can use their expertise and resources for long-term environmental sustainability.

In this edition, we also bring you a compelling interview with Runal Dahiwade, Founder & CEO of Peppermint Robotics, who shares insights on India's expanding role in the global robotics landscape. He talks about how Peppermint is engineering smarter commercial cleaning solutions and contributing to the country's innovation economy.

Also featured is a deep-dive research report on Renewable Energy in India. This report explores policy frameworks, industrial adoption, and how clean energy is reshaping India's economic and environmental trajectory.

Our feature on precision marketing in the automotive sector uncovers how data science, AI/ML, and emerging agentic AI systems are redefining customer engagement. Personalization, automation, and predictive analytics are becoming game-changers in how vehicles are marketed and sold.

Another article focuses on how Artificial Intelligence is fast becoming the 'brain' behind next-generation mobility systems—enabling smarter driving experiences, efficient energy utilization, and more responsive infrastructure.

At Machine Edge Global, our mission remains steadfast: to spotlight groundbreaking stories, transformative technologies, and the people driving progress across manufacturing, automation, and allied sectors. With every edition, we also aim to shine a light on the unsung heroes—those whose work behind the scenes is shaping a smarter, more sustainable industrial future.

Sanjay Jadhav

Sanjay Jadhav
Founder & Editor
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Reviving Urban Lakes: Mitsubishi Electric India's CSR Model for Climate Resilience

In an era where climate change and environmental degradation are at the forefront of global concerns, Mitsubishi Electric India is leading by example through its focused and far-reaching CSR initiatives. At the heart of this effort is the conservation and rejuvenation of urban lakes in regions like Talegaon and Pimpri Chinchwad—areas that face increasing ecological stress due to rapid urbanization. In an exclusive conversation with **Machine Edge Global, Atsushi Takase, Managing Director of Mitsubishi Electric India,** shares insights into the company's integrated approach to environmental sustainability, community engagement, and education. He elaborates on how these initiatives not only reflect the company's global vision of 'Changes for the Better', but also demonstrate a deeper commitment to building climate-resilient ecosystems and empowering local communities to drive long-term change.

ATSUSHI TAKASE,
Managing Director of Mitsubishi Electric India

The goal of Mitsubishi Electric India's CSR agenda is to go above and beyond compliance requirements by providing real environmental and social benefits at the local level.

Q. What inspired Mitsubishi Electric India to focus its CSR efforts on lake conservation and climate resilience, particularly in regions like Talegaon and Pimpri Chinchwad?

Mitsubishi Electric India's CSR efforts are focused on connecting with critical environmental problems and community needs. Talegaon and Pimpri Chinchwad were chosen because of their diverse natural habitats and the increasing environmental stresses that these urbanizing areas confront. Lakes and wetlands in these places are critical for biodiversity conservation, groundwater recharge, and climate stabilization. With a manufacturing presence in these regions, we see this initiative as a natural extension of our responsibility to the environment and the communities around us. The CSR initiative actively engages diverse stakeholders through innovative programmes that emphasize field action, education, skilling, knowledge-building, scientific approaches, and digital technology to promote the conservation of lakes and surrounding biodiversity in a changing climate. We are committed to protecting these key waterbodies and increasing climate resilience via scientific solutions and inclusive community engagement.

Q. The initiative brings together education, conservation, and community engagement. Why is this integrated approach important for achieving long-term environmental impact?

Ensuring the sustainability of environmental projects depends on a multidimensional approach. Supported by scientific knowledge, community ownership, and behavioural change, conservation efforts become long-term, relevant and successful. The programme promotes a thorough grasp of local ecosystems by combining educational resources, field-based activities, and stakeholder involvement. Leading scientists and experts, educators and communicators are associated with this initiative in developing easy-to-understand educational and learning resources for training various stakeholders. Additionally, it develops local capability over time to independently preserve and administer these environments. This whole approach guarantees that preservation is an evolving, community-led process rather than a one-time event.

Q. How does this initiative align with Mitsubishi Electric India's broader

Q. CSR philosophy and the global vision of 'Changes for the Better'?

This project is aligned with Mitsubishi Electric India's CSR policy, which emphasizes long-term social benefit, community welfare, and environmental sustainability. It also embodies the company's worldwide vision of 'Changes for the Better', which promotes proactive work toward social and environmental change. Using scientific knowledge, stakeholder cooperation, and capacity building, the project seeks to have significant and quantifiable effects. Through initiatives in line with the Sustainable Development Goals (SDGs) of the UN, Mitsubishi Electric India actively supports skill & community development in addition to environmental initiatives. These include programs for access to clean water, healthcare, and education. For instance, we have provided institutes and colleges, like it is, with resources like Acs and Industrial Automation Kits, including Robotic Arm, PLC (Programmable Logic Controller) and VFD (Variable Frequency Drive) training kits, for students to study and research on. Such initiatives are carried out to bridge the gap between industry and academia, to ensure that the youth is equipped with relevant skills for today's job market. Through such programs, we intend to help meet national sustainability objectives while honouring our obligations as a worldwide corporate citizen dedicated to building a more sustainable and inclusive society.

Q. What role do community stakeholders, especially Self-Help Groups and schoolchildren, play in driving the success of this initiative?

The success and viability of this initiative depend on community partners. Local women's groups, fisherfolk, and self-help groups are being trained as lake stewards to head conservation efforts, encourage eco-friendly behaviour, and increase knowledge at the local level. Ecologists and tree experts work with communities and recommend appropriate native species beneficial to the lake ecosystem, supporting avifauna, pollinators, and aquatic species.

Local communities can help conserve lakes through eco-friendly fishing, sustainable practices, and protecting lakes from plastic pollution and invasive species. The CSR initiative collaborates with teachers and engages students as citizen scientists in water quality monitoring programmes, conserving water resources, and promoting clean water, health, and hygiene. Interactive learning resources on water, sanitation, and hygiene are being developed with experts for school educational programmes. Educational resources are also prepared to promote the conservation of lakes and biodiversity through building knowledge and appreciation for natural assets in our cities. Empowering both present and future generations helps the project create community ownership and promote environmental responsibility and stewardship.

Q. Could you share how Mitsubishi Electric India plans to measure the outcomes or impact of this programme over the next year?

A strong framework of qualitative and quantitative indicators was used to track the impact of the programme. Around 100 participants across Talegaon and Pimpri Chinchwad are engaged in training and capacity-building activities, including self-help groups, students, teachers, and community participation in planting campaigns, and biodiversity documentation across 30 waterbodies. The focus was on building awareness around lake conservation and its role in strengthening climate resilience. Lakes help store freshwater, moderate local temperatures, and buffer against droughts, floods, and erratic rainfall. Other indicators include the volume of educational materials distributed, the number of Lake Stewards trained, and data gathered from water quality monitoring. These efforts marked small yet meaningful steps toward creating a significant impact and help us evaluate the effectiveness of the interventions.

Q. In the context of sustainability and climate action, how is Mitsubishi Electric India evolving its corporate responsibility agenda beyond compliance to drive real change in local communities?

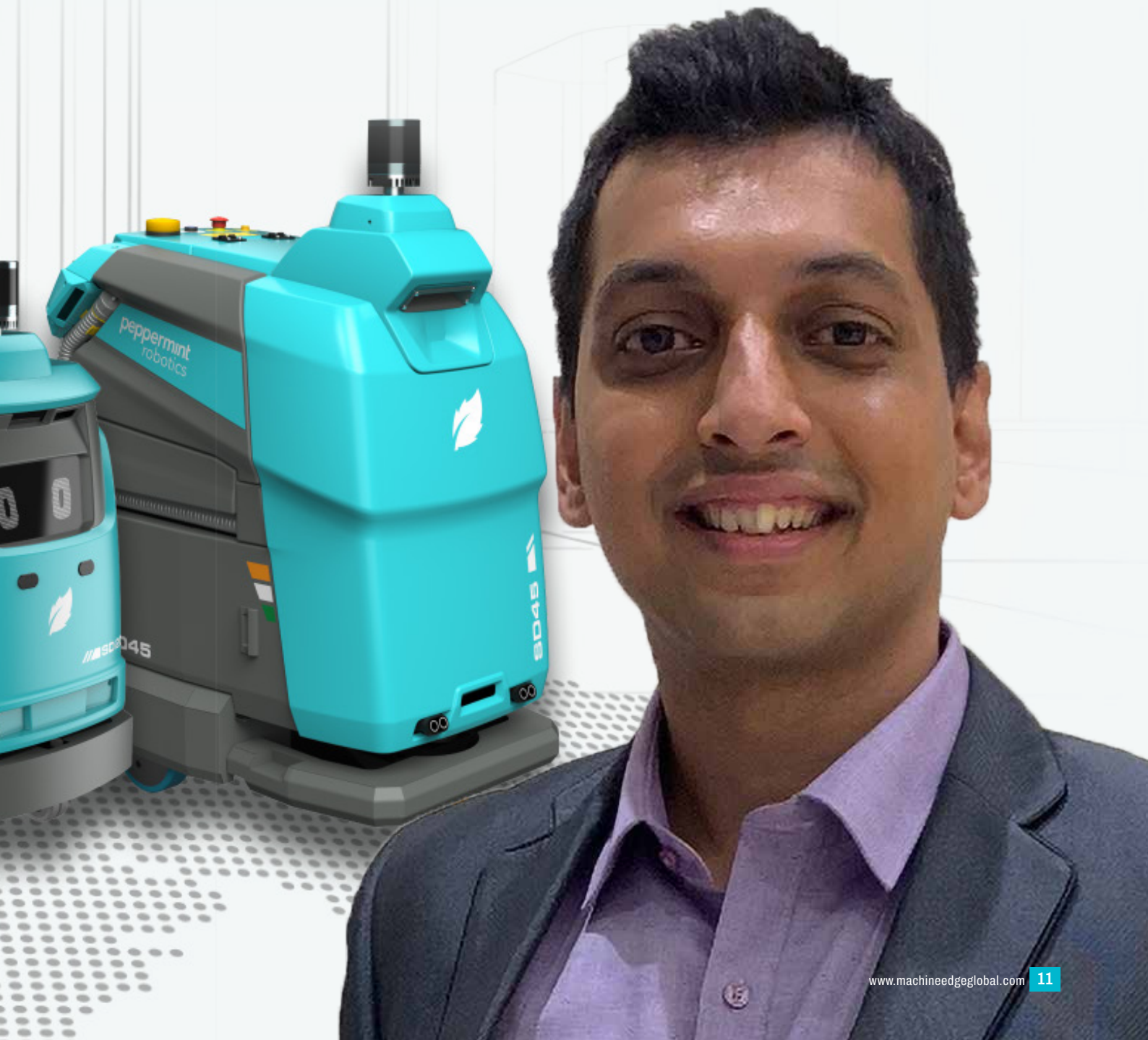
The goal of Mitsubishi Electric India's CSR agenda is to go above and beyond compliance requirements by providing real environmental and social benefits at the local level. Aligned with Mitsubishi Electric Group's purpose "to contribute to the realization of a vibrant and sustainable society through continuous technological innovation and ceaseless creativity", the company has incorporated sustainability as a strategic pillar of its operations.

Based on stakeholder views, scientific research, and local ecosystems, our approach is customized. Knowledge sharing, behavioural modification, and long-term ecological health are our top priorities. Through the use of digital and educational resources and cooperative efforts with knowledgeable partners, we are developing long-term and scalable solutions for sustainability driven by communities. This is consistent with our overall commitment to climate action, environmental resilience, and the well-being of local communities.

The company's Environmental Sustainability Vision 2050, which emphasizes environmental protection as a core corporate priority, serves as additional guidance for this commitment. The vision lays forth specific objectives to significantly reduce greenhouse gas emissions across all business operations and product lines.

"India is rapidly emerging as a key player in the global robotics industry"

As automation gains momentum across industries, Peppermint Robotics is leading the charge with intelligent, sustainable, and scalable robotic solutions. In this exclusive interview of Machine Edge Global with **Runal Dahiwade, Founder and CEO, Peppermint Robotics;** speaks about the company's origin, India's growing presence in the global robotics arena, and how Peppermint's innovative technologies are shaping the future of commercial robotics.



Q. Peppermint Robotics has been a game-changer in autonomous robotic solutions. Can you share the inspiration behind starting the company and the journey so far?

My journey into robotics started well before Peppermint. Back in 2011, I co-founded Carkhana.com, an online marketplace for auto accessories, which was eventually acquired. After that, I continued in the automotive space for a few years, recently I was associated with Refreshed Car Care, a sustainable car-care services company. During that time, I experienced and realized just how inefficient and labor-intensive traditional services workflows were—especially with rising costs and the shortage of skilled manpower.

That was the trigger to think of how automation could solve these pain points at scale.

The idea for Peppermint took shape around automating manpower-intensive workflows through intelligent, energy-efficient robots and technologies.

I approached SINE at IIT Bombay for support (incubator at IIT-B) , and that's where we got our first R&D grant and deep technical mentorship. Those early days were all about validating the use case, building our core technology, and understanding global market potential. We setup Peppermint at Pune to scale up and speed up our R&D, Production and first go-to market plans.

Q. India is increasingly positioning itself as a robotics export powerhouse. How do you see India's role evolving in the global robotics industry?

India is rapidly emerging as a key player in the global robotics industry, driven by its strong engineering talent, cost-effective manufacturing, and a growing ecosystem of deep-tech startups.

With government support through initiatives like 'Make in India' and increasing focus on export-ready, globally compliant products, Indian robotics companies are not only solving local challenges but also gaining traction in international markets.

Strategic partnerships, global certifications, and a focus on innovation are positioning India to become a leading exporter of robotics products and solutions in the coming years.

Q. The global commercial robots market is growing rapidly. What trends and opportunities do you foresee, and how is Peppermint positioned to leverage them?

The global commercial robots market is witnessing strong growth, driven by rising labor costs, demand for operational efficiency, and a shift toward automation in sectors like healthcare, hospitality, manufacturing, and commercial real estate. Key trends include increased adoption of autonomous mobile robots (AMRs), intelligent driven autonomouos navigation, and robots-as-a-service (RaaS) models.

Peppermint is well-positioned to tap into this momentum with its proven product portfolio in autonomous cleaning and material handling, deep-tech capabilities, and strong presence across

Asia, the Middle East, and North America.

By focusing on high-ROI use cases and building strategic global partnerships, Peppermint Robotics is geared to scale and lead in the next phase of commercial robotics adoption worldwide

Q. One of the standout innovations at Peppermint is the modular 'OS' & 'Skateboard' architecture. Can you explain how it enhances the capabilities and scalability of your robots?

- Peppermint's modular autonomous mobility software called 'OS' and commercial robotics grade electronics platform, called 'Skateboard', are key differentiator that significantly enhance both the capabilities and scalability of our robots.
- Designed in-house with automotive-grade standards, it acts as a universal operating system for robot navigation, central control module and power su-systems, that can be deployed across various robot types—be it cleaning or material handling, or other special pupose commercial grade robots.
- This common platform integrates autonomous navigation capability, motor controls, battery management, sensors, and mission planning into a single, adaptable unit.
- As a result, it simplifies development, reduces time-to-market for new products, and enables rapid customization for diverse applications, making our and our partners' robotic solutions highly scalable across industries and geographies.

Q. Sustainability is becoming crucial in technological advancements. How are Peppermint's autonomous robots contributing to sustainable practices and improving operational efficiency for your clients?

Peppermint's autonomous robots are designed with sustainability and efficiency at their core. By automating repetitive and resource-intensive tasks like industrial cleaning and material movement, our

robots help clients significantly reduce water, chemical, and energy usage compared to traditional methods.

They also optimize workforce allocation, enabling human staff to focus on higher-value tasks, thereby improving overall productivity. Notably, our Peppermint SD 45 Robotic Auto Scrubber features an integrated water filtration system called "Aqua Reclaim" that recycles and reuses cleaning water—saving up to 32 kilo litres annually. This not only supports greener operations but also delivers long-term cost and resource savings. Additionally, with smart navigation and data-driven operation, our solutions minimize waste and operational downtime—supporting greener facilities and long-term cost savings for clients.

Q. From a broader perspective, do you believe the robotics industry is at a strategic inflection point? If so, what market signals and technological advancements suggest that now is the right time for massive growth?

The robotics industry is indeed at a strategic inflection point. Several converging factors signal a shift from niche adoption to mainstream scalability: labor shortages across industries, increasing pressure for operational efficiency, and the global push for automation in both industrial and commercial environments.

Technological advancements—such as intelligent autonomous navigation, modular hardware like Peppermint's 'Skateboard' architecture, and sustainable features like water-recycling systems—have made robots more capable, scalable, and economically viable. Combined with supportive policy environments and growing investor interest, the timing is ideal for massive growth in robotics.

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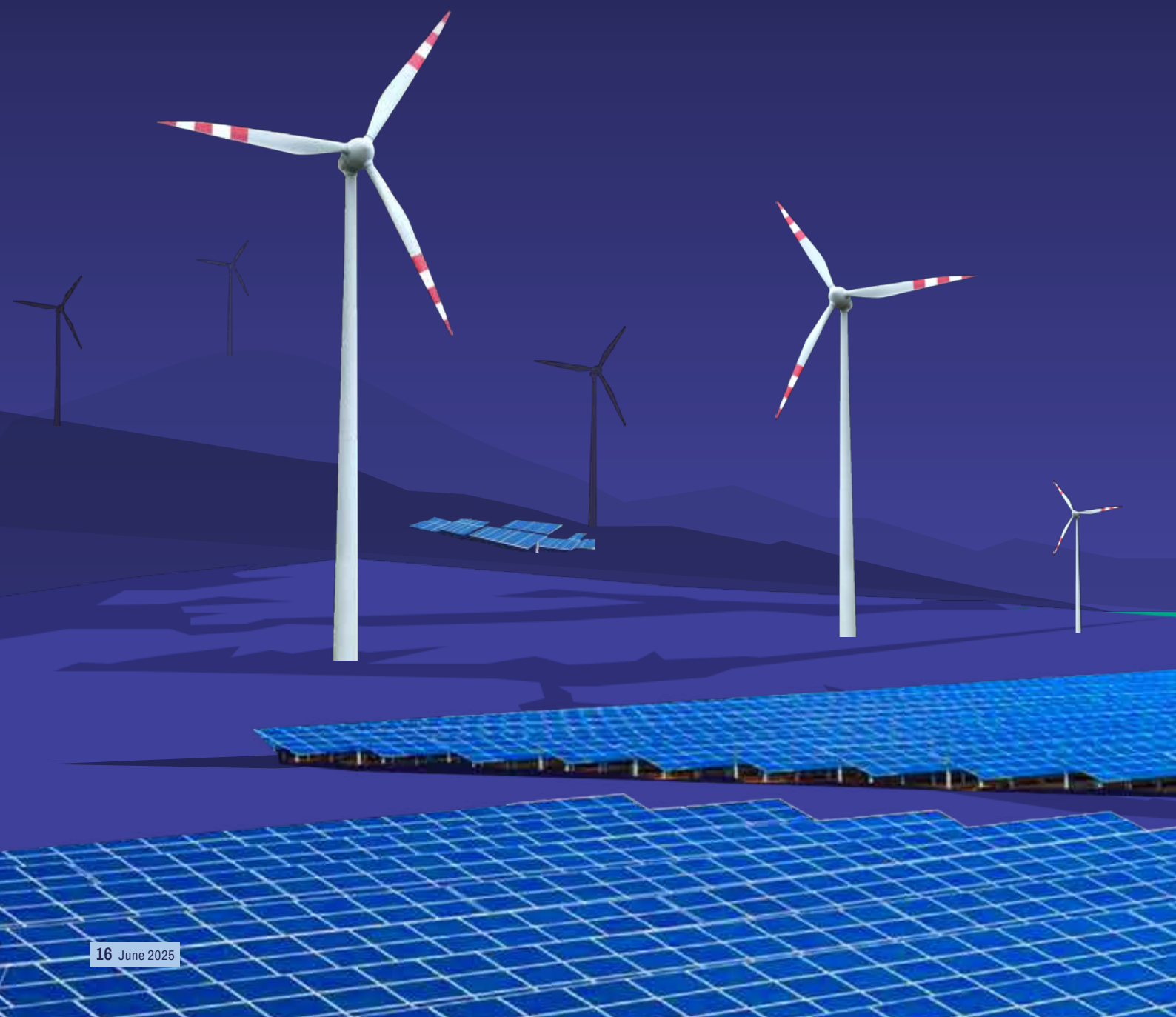
Renewable Energy in India

Driving India's Green Energy Goals



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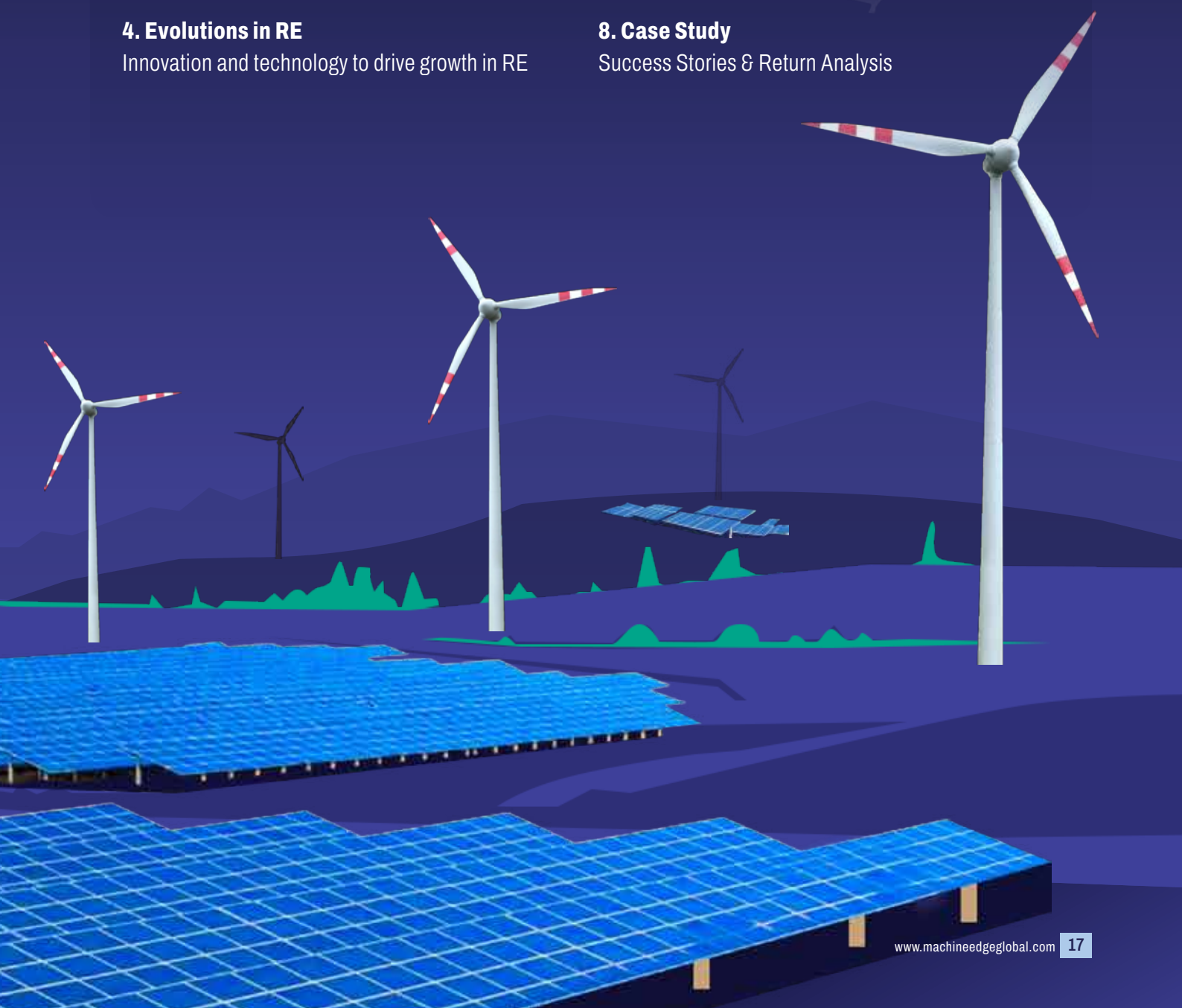
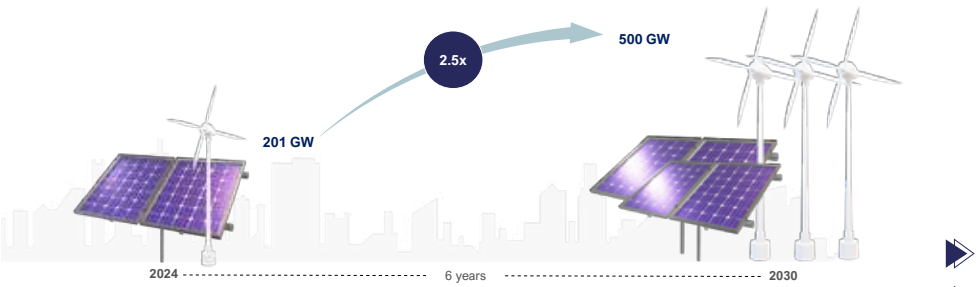


Overviewof RE in India

Current RE Landscape, Government Initiatives and Demand Supply Dynamics

Renewable Energy - An Exponential Growth Opportunity

Key for India to achieve its sustainability objectives



India's Sustainability and Energy Goals to Drive Growth in RE

500+ GW by 2030

50% Energy Requirement from RE

Net Zero by 2070

Source: Economic Survey'24, PIB, Public Sources, CEA & Avener Estimates
1 USD= INR 83

Top 5
In Solar & Wind Capacity

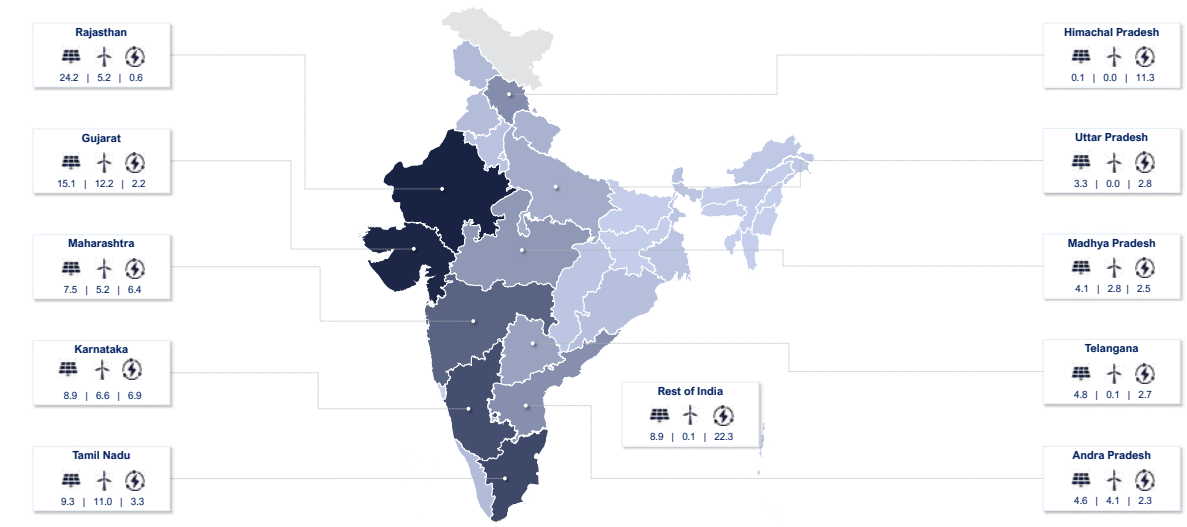
₹ 30 Lakh Cr
Opportunity in next 5 years

₹ 1.5 Lakh Cr
FDI received

13%
RE share in total energy generation in FY24

Snapshot of India's RE capacity

Installed RE Capacity grew at a CAGR of 20% in the past decade



Western India to drive growth in RE, owing to its strategic location and RE potential

Source: MNRE
Capacity in GW

solar wind Other RE

Policy Initiatives for Implementation of RE

Multiple schemes announced to incentivize investments and promote domestic production

CPSU

- Implementing agency – SECI, NTPC and IREDA. Currently SJVN & NHPC are also acting as implementing agencies
- Promotes solar power generation by offering VGF of INR 70 lakhs per MW (INR 55 lakhs from Tranche III)
- Maharatna CPSUs, OMCs plan to set up larger RE projects

ISTS

- Waiver of ISTS charges to encourage RE development
- Scheme extends to solar, wind, offshore wind, PSP, BESS and Green H2
- Results in tariff reduction by INR 0.8-1.2/unit which is c.1/3rd of Solar tariff & c.1/4th of tariffs for Hybrid projects

PM KUSUM

- Launched in Jul'19 with capital outlay of INR 35,000 crs
- 10,000 MW of de-centralized grid connected RE plants to be established
- 14 lakh standalone solar agricultural pumps to be installed
- Solarize 35-50 lakh grid connected solar pumps

Green Energy Open Access

- Rules notified in June'22
- Facilitate the generation, purchase, and consumption of RE by allowing consumers to access green power directly from producers or through power exchanges.

ALMM

- Launched in CY19 to boost domestic production
- From Apr'26, PV cells used in modules are also to be manufactured in India
- Green H2 projects currently not under the scheme's ambit

PLI

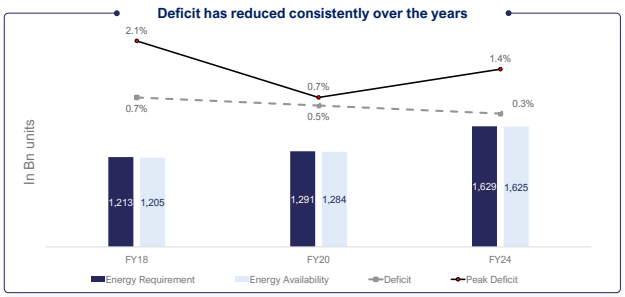
- Implementing Agency: IREDA and SECI
- T1 Capacity: 8,737 MW solar PV module manufacturing units
- T2 Capacity: 39,600 MW solar PV module manufacturing units
- Outlay: T1: INR 4,500 Cr T2: INR 14,000 Cr

Repowering

- New Policy unveiled in 2023
- Aims to maximize energy yield
- Aims to replace old turbines with new ones
- Interest rate rebate of 0.25% offered by IREDA for repowering projects

Power Demand – Supply Dynamics

India's high energy requirements to be met by robust RE capacity additions



Power Demand

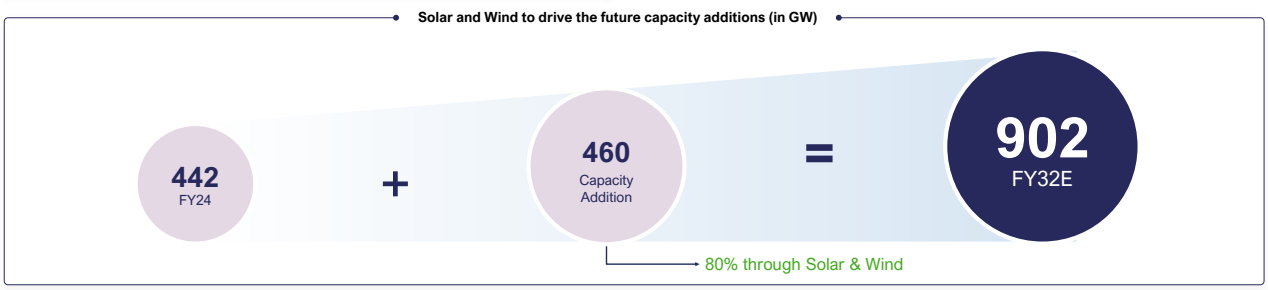
India is expected to witness notable surge in demand due to increase in economic activity, EV penetration and increasing digitalization (on account of set up of data centers, increase in AI usage etc.)

RE + Storage

RE coupled with storage solutions stands out as an effective approach to minimize this deficit without dependance on conventional power.

Key RE Drivers

Solar and wind with storage will be the major drivers of India's fast paced RE adoption to bridge demand supply gap



Source: CEA Annual Report 2022-23, Niti Aayog, NEP, Public sources

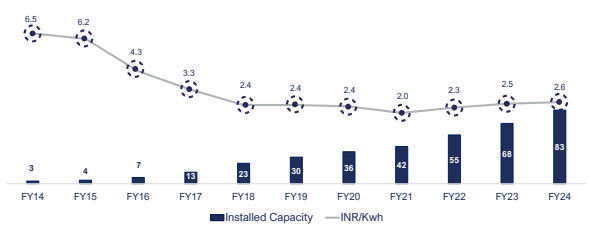
Solar Energy

Current Landscape, Value Chain and Recent Awards

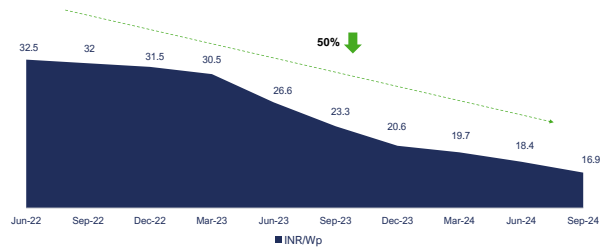
Solar Power: Current Landscape and Future Growth

Declining input costs and tariff rates have made solar the preferred RE source

Installed Solar Capacity (GW) and Solar tariffs



Declining Module Prices (Mono PERC 500 Wp)



Growth Drivers

- Low Capex, Opex and relatively simpler implementation
- Declining Module Prices resulting in improved IRRs
- Improved Efficiencies due to new technology (Bi-facial Top Con)
- Incentives on Roof-top, KUSUM and promotion of domestic manufacturing through ALMM & PLI

State	Tariff Range*	Average Tariff**
RJ	2.60 - 2.64	2.62
MH	2.42 - 3.93	2.88
GJ	2.20 - 2.89	2.52

Low tariff due to favorable location, land availability & relatively strong off-takers

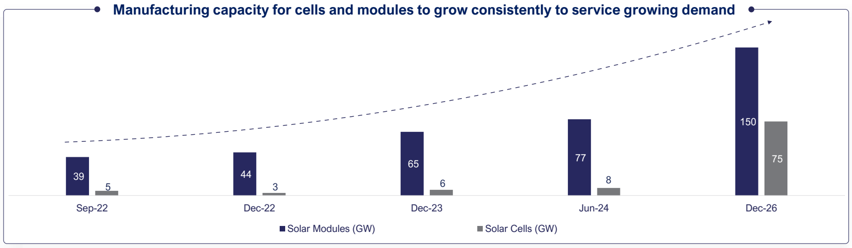
State	Tariff Range*	Average Tariff**
MP	2.14 - 3.90	2.75
AS	3.90 - 3.92	3.91
UP	3.17 - 3.23	3.20

High Tariff due to lack of land availability and lower credit profiles of the off-takers

Source: NEP, Avener Estimates, Public Sources

Module and Cell Manufacturing at an Inflection Point

Manufacturing of solar cells and modules is the next growth avenue for Solar in India

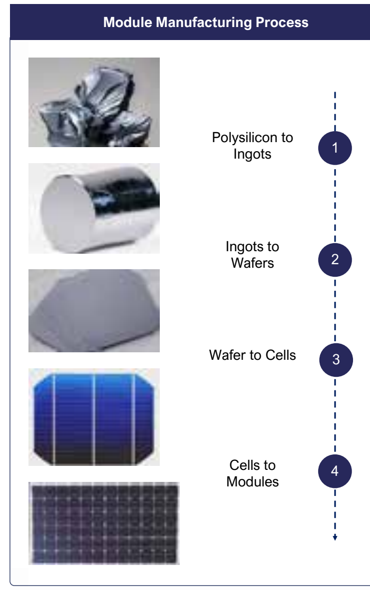


Cells & Module Manufacturing in the slow lane	Capacity ramp-up going forward
• Chinese modules being cheaper vis-à-vis Indian modules ($0.15 vs $0.22 in FY'24) • Cell manufacturing requires technical expertise and is a complex process • Capital Intensive	• Schemes like ALMM and PLI support domestic mfg • Reduced capex to set up production facilities due to favorable policy

Manufacturing in India

Challenges		Opportunities	
Untested Quality	Increase in tariff	Reduced forex risk for importers	Faster domestic procurement
Lack of Standardization	Cheaper Chinese Modules	Employment Creation	Increase in exports

Source: Public Sources, Mercom India



Solar Value Chain (1/2)

Key Players across the Value chain spectrum

Segment	Key Players
Cell Manufacturer	adani Solar, Jupiter, Websol Solar, Tata Power, ReNewSys, Indosolar
Module Manufacturer	Waaree, ReNew Power, Tata Power, adani Solar, Rayzon Solar, vikram solar, Saatvik, Emmvee, ReNewSys, Goldi Solar, Websol Solar, Solex, Grew, Pixon, First Solar
Cables & Conductors, Transformers	APAR, Polycab, KEI Wires & Cables, UKB, Hitachi Energy, Atlas, ABB, PND, PVJ Power
Inverters	Sungrow, ABB, Siemens, Fimer, TMEiC, Hitachi Energy, Goldi Solar, Eapro, Smarten, Servotec, Microtek, UTL Solar, Su-Kam, Livguard, Luminous

Solar Value Chain (2/2)

Key Players across the Value chain spectrum

Segment	Key Players
EPC	susten, Sterling & Wilson, Tata Power, Jakson, Belectric, Gensol, vikram solar, Grew, axis, Waaree RTL, Oriano, Datta Infra, Saatvik, Hartek, Loom Solar
Developers	ReNew Power, Tata Power, NTPC Green, JSW Energy, Hinduja Renewables, Avaada, Acme, blueleaf energy, Ayana, Juniper Green Energy, BluPine Energy, spring, engie, serentica
REICs/DISCOMs	SECI, NTPC, SJVN, NHPC, Mahavitaran
InvITs	IndiGrid, AnZen, seit

Recent Contract Awards

Given the huge growth opportunity and the derisked operating model, solar bids are on an uptick

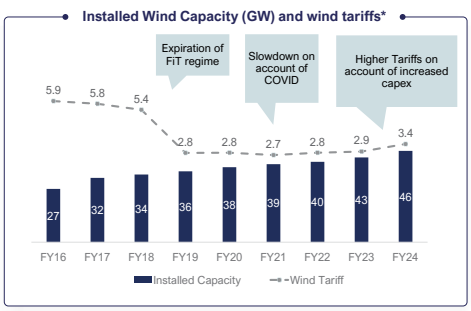
	FY25	FY25	FY25	FY25	FY25	FY25	FY24	FY24	FY24	FY24	FY24
Developer	Rays Power Infra, SAEL Industries, Refex Green, Renew, Mahindra Susten	Avaada, Essar, Susten, Rays Infra, Onward Solar	SAEL, NTPC Renewable, BluPine	Acme Solar, SAEL, Essar, Onward Solar, NTPC Renewable	KPI Green, Avaada, Solarkraft, NRCL, Hinduja Renewables	Apraava, Avaada, JSW, ReNew	Furies Solren, JSW Neo, Avaada	JSW Neo, Sunsure, UPC Renewables, NTPC	Avaada, Renew, Solairedirect, SAEL, NTPC	Furies, JSW, Avaada	Engie, NHPC, JSW Neo, SJVN, NTPC
Offtaker	NTPC	NHPC	SECI	SJVN	GUVNL	NTPC	NTPC	SECI	SECI	NTPC	GUVNL
Month	Oct-24	Sep-24	Aug-24	Aug-24	Jun-24	Jun-24	Mar-24	Mar-24	Mar-24	Mar-24	Mar-24
Capacity MW	1,200	1,200	500	1,200	500	1,500	1,500	1,500	1,500	1,125	1,125
Tariff (INR/ kWh)	2.50-2.51	2.56-2.57	2.48-2.49	2.52-2.53	2.67-2.72	2.68-2.69	2.59-2.60	2.56-2.57	2.57-2.58	2.59-2.60	2.62-2.67

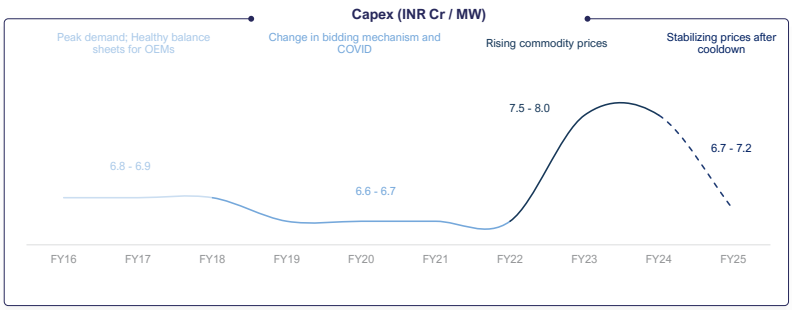
Wind Energy

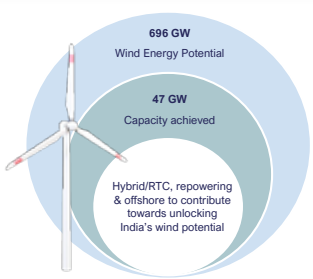
Current Landscape, Value Chain and Recent Awards

Wind Sector at a Glance

India's huge wind energy potential has led to a gradual but consistent increase in installed capacity







Challenges

- Land Availability
- Removal of FiT
- Higher Capex
- Opex & Wind speed variability

Growth Opportunities

- Higher Tendering Opportunities
- Improved Technology
- Tariff Rationalizing
- OEM's improving Financial Health

Source: NEP, MNRE, Public sources

Wind Value Chain (1/2)

Key Players across the Value chain spectrum

Cables & Conductors	
Transformers	
WTG & EPC	

Wind Value Chain (2/2)

Key Players across the Value chain spectrum

O&M	
Developers	
REICs/DISCOMs	

Recent Contract Awards

FY24 saw wind tariff rationalizing to INR 3.4-3.6/kwh, however, projects in FY25 are majorly being bid out on a Hybrid basis

	FY25	FY24	FY24	FY24	FY24	FY24	FY24	FY23	FY23	FY23	FY23
Developer	Powerica	JSW Energy	Juniper, EDF, Alfanar	SJVN, O2, Scatec	Avaada, Juniper	Apraava, SJVN, Green prairie	Juniper, Blupine, Evergreen	Juniper, Blupine, Acme, EDF	GSECL, EDF, Juniper, Ayana, Blupine, O2, Acme	NTPC, EDF, JSW, Torrent	Sembcorp
Offtaker			GUVNL				GUVNL	GUVNL	GUVNL		
Month	Oct-24	Feb-24	Jan-24	Dec-23	Nov-23	Jun-23	May-23	Jan-23	Jul-22	May-22	Apr-22
Capacity MW	50	500	164	600	100	690	240	300	500	1,100	50
Tariff (INR/ kWh)	3.81	3.6	3.42-3.45	2.9-2.95	3.58-3.59	3.18-3.24	3.11-3.17	2.91-3.01	2.84-3.27	2.89-2.94	3.11

Evolutions in RE

Innovation and technology to drive growth in RE

Evolutions in the RE Space

Stimulus to the RE growth story, while addressing the inherent limitations

	Solar & Wind	Hybrid / FDRE/ RTC/Storage
Power Stability	Intermittent power generation	Consistent supply due to multiple sources
Efficiency Factors	Lower CUFs	Higher CUFs
Grid Load	Affected due to peak hours and varying demand	Improved grid stability and efficiency
Location	Geographically dependent	Co-location advantage
Availability	Available at respective cycles	Round the clock availability
Operational Risks	Individual projects easier to manage	Higher Coupling risks

Bids Awarded (in GW)

Particulars	FY23	FY24	H1 FY25
	4.5	26	6
	2.5	1.6	1.6
	2.4	15.8	14.2

Hybrid Storage & FDRE Projects have emerged as preferred mode of RE generation with a YoY increase in bid awards by 6x

Hybrid Projects provide reliability and consistency, addressing the concerns in traditional RE Projects

Evolving Themes in the RE space

Future Developments slated to transform India's RE landscape

The RE space is booming with investments from strategic, financial investors as well lenders making capacity ramp up the next step for RE players

Solar Energy

Growth to be driven by:

- Continued priority to solar energy schemes & emphasis on floating solar projects to optimize space usage
- Decentralized solar energy systems, including microgrids and community-level projects
- Exponential growth opportunities for module & cell manufacturers

Wind Energy

Growth to be driven by:

- Standalone wind projects & repowering of wind sites
- Demand for hybrid, FDRE, storage projects and off-shore wind
- OEMs to see healthy orderbook on account of capacity expansion

Hybrid Renewable

Combination of solar, wind, & storage technologies, to be more common which will improve energy output consistency and optimize land and resource use while addressing grid stability issues.

Others

- **Green H2**: Critical for decarbonizing heavy industries as India aims to establish itself as a global hub
- **Electric Mobility Integration**: The rise of EV is expected to drive greater demand for clean energy
- **Digitization & Smart Grids**: Technologies like AI, IoT, & Blockchain will optimize power generation, grid management and energy distribution
- **BESS**: Advanced battery technologies, including flow batteries & H2 based storage are essential to balance the intermittency of solar and wind power. Falling lithium-ion battery prices are encouraging broader adoption of storage solutions.

Way Forward

Key Players

Key Players in RE space across value chain

Key Established Players in the IPP Space

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
adani	Present across all RE verticals with the largest operational capacity in the country. Plans to enter Green H2, BESS	11 GW	24	7,735	7,222	50,686	Ind AA-	Promoter: 51% Total Renewables: 20% QIA: 2.69%	Google partners with Adani for RE supply
ReNew Power	One of India's largest RE IPPs with presence in all RE verticals with plans to enter Green H2, BESS	10 GW	24	9,653	6,922	56,700	CARE A+	Promoters: 100%	Microsoft And ReNew enter into RE partnership In India
AVAADA	Solar Power generator, with presence in module manufacturing and plans to enter Green H2 / NH3, and PSP	4 GW	23	1,546	1,413	-	IND A+	ADB, DEG, NDFC	Avaada Group recently made a commitment to invest INR 20,000 crs in Odisha
greenko	Marquee developer with presence across 15 states. Market leader in PSP	8 GW	23	2,561	2,108	-	CARE A+	TPG, GIC, ADIA	Greenko Group co AM Green and SJVN ink 4,500 MW renewable energy supply contract
JSW Energy	Diverse portfolio of RE and conventional assets, with expansion plans in BESS, Green H2 & module manufacturing	8 GW	24	11,941	5,387	26,636	ICRA AA	Promoters: 69% Others: 31%	JSW Group to acquire 3 captive RE power assets (125 MW) from Hetero Group for INR 630 Cr
TATA POWER	India's largest integrated power utility; present in all RE verticals. Capex planned in GreenH2, BESS	6 GW	24	10,175	3,421	1,405	CRISIL AA+	Promoters: 100%	Tata Power signs 25-year deal to power Noida Airport with wind and solar energy

Key Emerging Players in the IPP Space (1/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
	Renewable energy platform focusing on C&I and utility projects	4 GW	23	142	83	-	CARE A-	CIP, AIIB, Lightstone	Sumitomo, Ampin Energy Form Green JV
	Backed by marquee investors, O2 Power is a fast emerging RE platform focusing on Solar, Wind and RTC projects	4 GW	23	402	2	125	CARE A2+	EQT, Temasek	In the process of selling its assets worth USD 1bn
	Utility-scale renewable energy platform with wide portfolio comprising of solar, wind, RTC, and green hydrogen projects	1.6 GW	24	856	721	6,802	ICRA AA-	NIIF, BII, Green growth India fund	NTPC Green Energy and ONGC Green Energy's JV has tabled the highest bid of about USD 650 million to acquire Ayana
	IPP & operator of solar, wind & hybrid projects and experience in conceptualizing, building, & developing RE	930 MW	24	391	371	2,410	ICRA A+	Promoters	GUVNL Awards 200 MW Wind Power Projects to Jakson Green, Juniper Green Energy, And RIH Renewables In Gujarat
	Produces wind & solar power and develops grid-connected solar and wind parks along with C&I developments	2 GW	24	328	253	3,510	CARE A	Actis, Tata capital	BluPine commissioned a 120 MW solar plant in Gujarat

Key Emerging Players in the IPP Space (2/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
	Founded in 2017, Sprng focuses on renewable energy, cleantech, and energy efficiency	2 GW	23	1,011	1,068	-	CARE AA+	Actis, Shell	Sprng Energy, AMPIN, Jupiter, ReNew, Avaada win NTPC's 1GW Hybrid Auction
	JV of the Hero Group established to manage wind, solar and hydro power plants	5 GW	24	1,462	1250	10,428	CRISIL A+	Promoters	Hero Future Energies plans to invest $20 bn in renewables over 6 years
	IPP comprising of ground mounted solar plants; entering the wind and hybrid space	125 MW	24	254	234	2,727	CRISIL AA-	Promoters- 100%	KPI green, Avaada, Blupine, NRC and Hinduja win GUVNL's 500 MW Solar Auction
	Italian major, headquartered in Rome. In India, it has 5 operating plants with an installed capacity of 760 MW	760 MW	23	266	251	-	-	Promoters- 100%	Enel picks HSBC to sell India green portfolio
	Decade old IPP focused on developing and maintaining solar projects	1 GW	24	1,372	1,114	8,421	CRISIL A1	Promoter- 100%	ACME Sun Power secures INR 3,753-cr term loan from state-owned REC for development and construction of a 320-MW FDRE

Key Players in the EPC Space (1/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
JAKSON	Engaged in Solar EPC, substation & transmission projects & authorized supplier of Cummins gensets	5+ GWp	24	4,946	310	303	CRISIL AA-	Promoters: 100%	Jakson Group plans to raise USD 476 mn for RE capacity expansion
Oriano	Engaged in turnkey solar EPC for utility-scale solar power plants, solar kits, solar farms and rooftops.	729 MW	24	337	32	12	CRISIL BBB	Promoters: 100%	Oriano Solar wins EPC order for 184 MWp PV projects in MP
TATA PROJECTS	Engaged in providing EPC services for setting up power generation plants	-	24	17,760	-923	5,213	IND AA	Promoters: 100%	Recently bagged projects to evacuate power for green hydrogen projects
GENSOL	Solar designing and engineering, solar advisory, solar EPC and O&M	750+ MWp	24	963	260	1,397	CARE BB+	Promoters: 63% Others: 37%	Gensol Engineering wins INR 600 crore EPC contract for 116 MW solar projects in Gujarat
susten	Engaged in manufacturing solar power products and EPC services.	3 GW	24	195	101	-	IND A+	Promoters: 70% OTPP: 30%	Recently formed InvIT SEIT with ~1.5 GW of solar projects

Key Players in the EPC Space (2/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
SUZLON	Leading RE solutions provider, and is emerging as the 'foremost flag-bearer' of the green energy sector	15 GW	24	6,497	1,029	-	CRISIL A-	TPG	Recently bagged 1,166 MW wind energy order from NTPC Green Energy
Vestas	Operates and maintains high quality WTG	5 GW	24	3,780	327	1,418	-	Promoter- 100%	Secured 130 MW order in India with Vibrant Energy
inoxwind	Key player focusing on the generation and sale of wind energy and providing EPC services to wind farms	3 GW	24	1,746	324	205	CRISIL A	Promoters- 48% Others- 52%	Inox Wind receives LoI from IGREL Renewables for 550 MW wind project
SIEMENS Gamesa	Provides offshore and onshore wind turbine solutions and O&M, asset optimisation & repair services	-	23	6,077	-1,146	2,543	-	Promoters	Siemens Energy plans to sell Indian wind business at $1bn valuation
SENVION	India's 5th Largest wind turbine manufacturer	-	24	77	20	74	-	Alfanar	Senvion India plans to double its manufacturing capacity by FY26 and invest INR 840 Cr in R&D

Key Players in the OEM Space (1/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
	Products include solar PV modules, lanterns, street lighting systems, water pumps, home light systems, power plants	6 GW	23	1,444	113	733	CRISIL BBB+	Promoter: 97% Other: 3%	Recently bagged orders worth INR 560 Crores from two IPPs for Solar Modules and Cells
SUZLON	Provides complete turnkey solutions from design to life-cycle asset management	15 GW	24	6,497	1,029	-	CRISIL A-	Promoter: 13.27% Public: 86.73%	Recently bagged India's Largest wind energy order of 1,166 MW wind energy from NTPC Green
WAAREE RTL	Manufactures PV modules, inverters, water pumps, solar- thermal, garden light, study lamp and inverters	444 MW	24	10,717	1,614	276	CARE A	Promoters: 71% Others: 29%	Waaree Energies recently crossed the INR 1 lakh crore Market cap mark post its listing
vikramsolar	Manufacturer of solar PV module also offering lighting systems, power packs, solar EPC solutions, design, install and commissioning of solar projects	4 GW	24	2,511	399	809	ACUITE A-	Promoter: 76% Others: 24%	Vikram Solar recently filed its DRHP for an IPO worth INR 1,500 Cr
inoxwind	Focuses on the generation and sale of wind energy and provides EPC services to wind farms	376 MW	24	1,746	324	205	CRISIL A	Promoter: 48% Public: 51%	iShares Global Clean Energy Buys stake worth INR 1,517 Crore via Bulk Deal

As on Apr'24, Envision had a 40% share in the Wind OEM space. However, the same is not included above due to limited data availability

Key Players in the OEM Space (2/2)

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

Figures INR Cr

Companies	Description	Scale	FY	Revenue	EBITDA	Net Debt	Rating	Shareholding	Key/ Recent Highlights
adani	Solar PV manufacturing arm of Adani Group,	6 GW	24	7,735	7,222	50,686	Ind AA-	Promoter: 51% Total Renewables: 20% QIA: 2.69%	Adani wins bid to supply 6,600 MW of electricity at INR 4.08/unit tariff
Vestas	2 decades of experience in Operating & maintaining WTG having installed ~1700 Wind turbines across 7 states	5 GW	24	3,780	327	1,418	-	Promoters	Vestas Secures 130 MW Wind Turbine Order from Vibrant Energy in India
GOLDI SOLAR	Engaged in manufacturing & trading of PV modules & EPC. Product range also includes solar water pumping system - surface & submersible	3 GW	24	1,756	126	320	CARE BBB-	Promoters: 100%	Goldi Solar plans to go public to fund INR 2,700-crore expansion
SAATVIK	Manufactures rooftop, ground mounted solar PV modules, polycrystalline, mono crystalline modules, etc and also offers EPC services	NA	23	621	27	145	CRISIL BBB	NA	Saatvik Green Energy bags INR 302 crore order from MAHAGENCO for 200 MW solar module supply
RenewSys	Manufacturing of International electrotechnical commissioned solar module components	3 GW	23	1,791	122	318	ICRA A	Promoters: 100%	Plans INR 6000 Cr investment in Telangana

Funding Dynamics

Funding landscape of RE space

Funding Dynamics

Well established funding landscape owing to operational history of RE projects and the sector's growth potential

Project Cost

Particulars	Value (.c)
Land Cost	5%
Plant & Equipment	70%
Civil Works & Other Costs	25%
Total	**100%**

During Implementation

Particulars	Value
Loan to Value	70-80%
Rate of Interest	8.75-9.25%
DSCR	1.20-1.25x
Working Capital Facility	Can be availed

Post Implementation

Particulars	Value
Loan to Value	85-90%
Rate of Interest	8.25-8.75%
DSCR	1.15-1.20x

LTV

The projects are initially funded at an LTV of **70-80%** which can be further optimized by c.20% post installation

Interest Rate

Pre-Installation: ~8.65%-9.25%*
Post-Installation: Reduces by 0.25%-0.50% due to elimination of implementation risk

DSCR

Considering the fixed nature of revenue and reduced off taker risk, DSCR can be optimized to **1.15-1.20x** post installation

WC Facility

Lenders provide **working capital limits** during operational period to mitigate any risk on account delay in payment from off-takers

** At current MCLR*

Marquee Investors & Deals

Strong Investor Interest driving pace of dealmaking across the globe

Global Investors

RE attracts a range of high-quality investors including DFIs, SWFs and PE Funds

Private Equity, SWFs and Pension Funds

GIC · KKR · CDPQ · Ontario Teachers' Pension Plan · actis · APG · AP Møller Capital · Temasek · TPG · Stonepeak · OMERS · BlackRock · FMO · CPP Investments · Mubadala · PIF · CIP · AMP · ADIA · Brookfield · Everstone Capital

DFIs

KFW · ADB · European Investment Bank · AIIB · Eurasian Development Bank · IFC · JBIC · British International Investment · Norfund · Swedfund · PROPARCO

Strategics

TotalEnergies · Vitol · GPSC · Shell · PETRONAS · enel

Marquee Domestic RE Deals

Significant capital infusion has happened in recent years owing to the robust pipeline

	Sep'24	Aug'24	Aug'24	Aug'24	Jul'24	May'24	Apr'24	Apr'24
Target	INOXGFL			RENOM			JSW Energy	RELIANCE Power
Deal Size	300	1,245	2,280	400	1,660	292	5,000	132
Investors	Multiple (incl Madhu Kela and Akash Bhansali)		IFC, ADB, KFW	SUZLON	Brookfield	responsAbility	Multiple Investors	JSW Energy
Remarks	Aims an installed RE capacity of 2 GW by FY27	Displace coal power generation through deployment of RE	Aims to reach 3.5 GW of RE assets by FY26	Targets to achieve 32+ GW wind assets	Targets to achieve 3+ GW capacity over 5 years	Implement projects in C&I space	QIP to repay debt and accelerate growth plans	Acquisition of 45 MW assets
Growth Capex	✓	✓	✓		✓	✓	✓	

Deal Size in INR Cr

Marquee Domestic RE Deals

Significant capital infusion has happened in recent years owing to the robust pipeline

	Mar'24	Jan'24	Jan'24	Dec'23	Aug'23	Aug'23	Jun'23	Apr'23
Target	ACME	ReNew	seit		adani		AVAADA	CleanMax
Deal Size	1,700	1,650	486	300	3,930	350	1,930	2,988
Investors	BluPine Energy	IndiGrid	AIIB	YES BANK	QIA	Norfund	GPSC	Brookfield
Remarks	Acquisition of 369 MW assets	Acquisition of 300 MW assets	Anchor Investor for India's largest RE InvIT	QIP Fundraise	Acquisition of 2.7% stake	Second round of equity infusion by Norfund	Growth capital for green H2, NH3 and solar manufacturing	Acquisition of 51% with a minority primary infusion
Growth Capex			✓	✓		✓	✓	✓

Deal Size in INR Cr

Marquee Global RE Deals

Significant capital infusion has happened in recent years owing to the robust pipeline

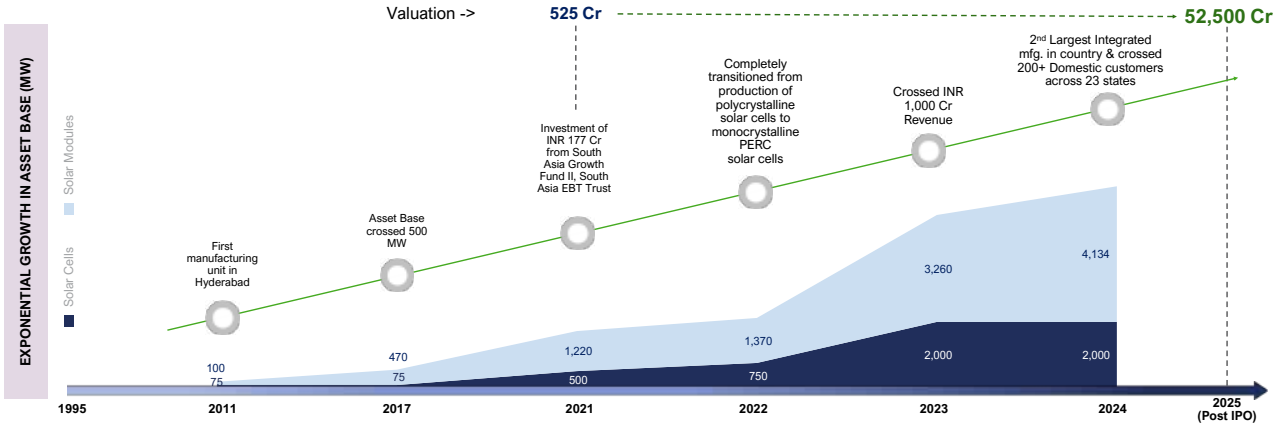
	Oct'24	Sep'24	Jun'24	Dec'23	Dec'23	Nov'23	Oct'23	Aug'23
Target	Ørsted South Fork Wind; Ørsted Revolution Wind	Reverion	Terna Energy	energyRe	Voltfang	nrg	Atlas	steag
Deal Size	$745 Mn	€56 Mn	€3.2 Bn	$1.2 Bn	€8 Mn	$1.75 Bn	$646 Mn	$2.8 Bn
Investors	Global Infrastructure Partners	**Multiple**	Masdar	Glentra; nova holdings; pka	**Multiple**	Constellation	engie	Asterion
Remarks	Eversource sold 50% stake in South Fork Wind & Revolution Wind to GIP	Series A funding for its power plants	Largest ever energy deal on Athens Stock Exchange	Growth cap to expand RE portfolio	Series A funding to expand Voltfang product range	Acquisition of 44% stake in South Texas plant	Acquisition of operating projects in Brazil	Focus on transitioning into a sustainable energy supplier
Growth Capex		✓		✓	✓		✓	✓

Case Study

Success Stories & Return Analysis

Case Study 1- Premier Energies Limited

An integrated solar cell and solar module manufacturer with experience of 3 decades



Launched IPO in August 2024, for raising capital for growth and has plans to establish TOPCon solar cell line with greater efficiencies

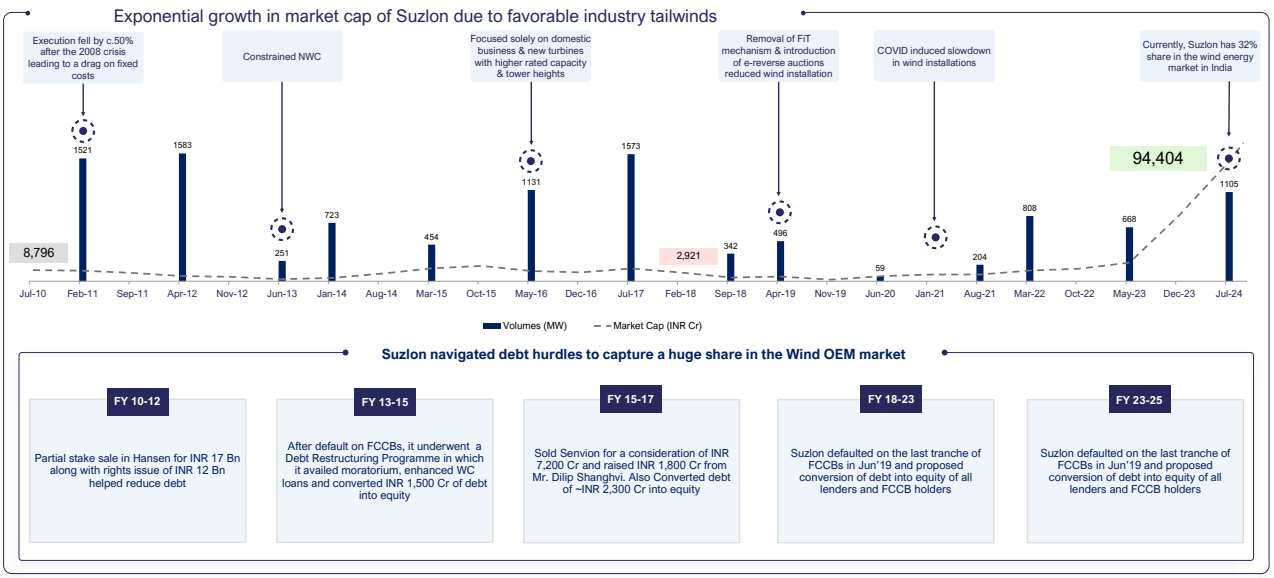
Reasons for outperformance

Incorporated in 1995

- Company's backward integration helped it gain access to the market for DCR modules.
- High entry barriers like huge capital, technical expertise and long lead times to establish a manufacturing line limited competition
- Expanding overseas presence and increasing exports, especially in the U.S
- Develop and grow rooftop solar offerings
- Expanding and upgrading manufacturing capacities using the latest technology

Case Study 2- Suzlon Energy

Suzlon Energy became a turnaround story by its resilient journey to profitability in India's challenging wind energy landscape



Suzlon navigated debt hurdles to capture a huge share in the Wind OEM market

FY 10-12
Partial stake sale in Hansen for INR 17 Bn along with rights issue of INR 12 Bn helped reduce debt

FY 13-15
After default on FCCBs, it underwent a Debt Restructuring Programme in which it availed moratorium, enhanced WC loans and converted INR 1,500 Cr of debt into equity

FY 15-17
Sold Senvion for a consideration of INR 7,200 Cr and raised INR 1,800 Cr from Mr. Dilip Shanghvi. Also Converted debt of ~INR 2,300 Cr into equity

FY 18-23
Suzlon defaulted on the last tranche of FCCBs in Jun'19 and proposed conversion of debt into equity of all lenders and FCCB holders

FY 23-25
Suzlon defaulted on the last tranche of FCCBs in Jun'19 and proposed conversion of debt into equity of all lenders and FCCB holders

Sensitivity analysis of RE Projects

IRRs and their sensitivity for a proposed 140 MW (DC) Solar Project & 100 MW (DC) Wind Project

Assumptions for Solar Project

Particulars	Details
Capacity	140 MW
PLF	19%
Tariff	INR 2.5/unit
D/E	75:25
ROI	9%

Sensitivity Analysis for Solar Project

Module Cost ($ Cents/Wp)	Tariff (INR/unit)	IRR (%)
19	2.5	26.6%
20	2.5	21.4%
21	2.5	17.0%
22	2.5	13.3%
23	2.5	10.3%
24	2.5	7.7%
25	2.5	5.6%

Sensitivity Analysis for Wind Project

Capex (INR Cr/MW)	Tariff (INR/unit)	IRR (%)
6.6	3.4	20.76%
6.8	3.4	18.25%
7.0	3.4	16.0%
7.2	3.4	14.0%
7.4	3.4	12.2%
7.6	3.4	10.6%
7.8	3.4	9.1%

Assumptions for Wind Project

Particulars	Details
Capacity	100 MW
PLF	32%
Tariff	INR 3.4/unit
D/E	75:25
ROI	9.5%

Reimagining Precision Marketing in the Automotive Industry with **Data Science and Agentic AI Systems**

As automotive buyers grow more digitally savvy and expect personalized experiences, traditional broad-based marketing methods are falling short. This article explores the rise of precision marketing in the automotive industry—how data science, AI/ML, and agentic AI systems are transforming customer engagement. It delves into the tools, strategies, and organizational shifts needed for automakers to create more relevant, timely, and effective marketing that not only boosts conversions but also deepens customer relationships.

H. Vasanth Munnamgi
Associate Principal, MathCo

Anwar Altaqi
Principal, MathCo

For several decades, automotive marketing was rooted in static and generalized outreach through television commercials, print ads, and mass email campaigns. Though these approaches have recorded success in targeting customers in the past, their effectiveness has diminished considerably in the current day, where consumers interact with companies digitally. Consumers now expect brands to know their preferences and to engage with them in ways that are both relevant and timely. Traditional marketing lacks the ability to meet these expectations. Messaging in broad marketing is mostly generic and disconnected from the needs of the target audience, resulting in low engagement levels and high advertising waste.

Broad marketing approaches, in an effort to capture a diverse customer base, are often generic and cast a wide net, thereby reaching many uninterested consumers and decreasing the return on investment. Because such promotions do not align with their interests, people become desensitized to such generic campaigns, leading them to eventually unsubscribe. Further, these campaigns fail to nurture customer relationships, which is crucial to long-term engagement or brand loyalty. In this ever-volatile and competitive automotive market, broad campaigns fail to keep up with the pace of changing consumer preferences.

Precision Marketing in Automotive

There is a need for a fundamental shift toward dynamic and data-informed personalization. Precision marketing in the auto industry needs a strategic approach backed by data to effectively engage with the right audience, on the right platform, and at the right time. OEMs could leverage data from various sources like CRM systems, online browsing behavior, telemetry data, and third-party customer data in order to tailor messages to individual customers. Dynamic machine learning algorithms and advanced AI models enable and enhance precision marketing by analyzing such varied and vast datasets to uncover customer preferences and behaviors. These techniques provide actionable insights in terms of personalized recommendations and focused messaging. They also provide predictive insights, such as the risk of a customer defecting from an OEM, the probability of a customer being in-market for vehicle purchase, effectiveness of incentives offered, loyalty score of a customer, etc. -- helping marketers to reach out to the right audience.

Even today, in the decision to purchase a vehicle, a lot of research and gaining awareness happens online, whereas the actual conversion or purchase happens at the dealership. Precision marketing can help bridge this gap between online and offline experience by coming up with recommendations of a touchpoint, follow-up message, or personalized offers to nudge the lead or a hand raiser towards conversion.

With organizations doubling down on cost control and demanding greater effectiveness from every dollar spent, there is a renewed focus on reducing customer acquisition cost (CAC). This shift has elevated the role of data science and AI/ML models, which are crucial in enhancing precision marketing and driving better ROI. By applying advanced analytics and machine learning, marketers can move beyond broad segmentation to understand customers at a more granular level -- identifying who they are, what they need, and when they are most likely to engage. This targeted approach ensures that marketing efforts are more relevant and timely, leading to higher engagement and conversion rates. Moreover, data science and agent-based AI systems enable continuous learning from campaign performance, allowing marketers to refine their strategies in real time. The result is a smarter and more efficient use of marketing budgets and stronger business outcomes.

Personalizing Marketing

Predictive behavioral modeling helps understand the intent behind customer actions by analyzing engagement patterns across channels. For example, if a customer frequently interacts with off-road vehicle

content, views adventure accessories, and searches for towing capacity specifications, recommendation systems built using AI/ML techniques could identify a lifestyle-driven motivation that is possibly linked to outdoor travel or utility needs. Even without an explicit statement, these digital clues indicate what matters most to the customer. Behavioral models transform this data into actionable insights, allowing OEMs to position vehicles not just by their specifications, but by aligning with the customer's lifestyle and emotional drivers, thereby making marketing more relevant and compelling.

Agentic AI systems have the potential to take precision marketing to the next level by enabling real-time personalization. AI agents could monitor customer journeys on OEMs' websites and create marketing content dynamically. Say, a prospect is known to have browsed about environment and sustainability, and an agentic AI could recommend EVs and the ecological benefits of such vehicles, along with information on tax credits. Similarly, if an existing customer is in-market for a purchase and the telemetry data reveals travel in locations well-connected with charging stations, the website content could be tailored by agentic AI to suggest EVs that are a look-alike of the existing vehicle owned, while highlighting access to charging infrastructure.

Beyond acquisition, data science techniques are essential for measuring customer engagement after the sale. Predictive maintenance alerts based on vehicle usage and in-vehicle diagnostics showcase the OEM's keenness about vehicle safety and strengthen trust and loyalty towards the brand. Sentiment analysis from surveys and product reviews makes the voice of customers heard and enables proactive issue resolution/ product quality fixes. Recommendation systems can suggest accessories or upgrades tailored to usage patterns. These are only a few examples of how automakers can build and strengthen their relationship with customers, improving customer lifetime value and retention rates.

Enabling Precision Marketing

To implement precision marketing effectively, automakers need a data stack that integrates data ingestion, warehousing, and activation. This includes platforms like customer data platforms (CDPs), marketing automation tools, and real-time analytics engines. Cloud computing platforms have made it possible to provide infrastructure, scalability, and tools needed to make the technological implementation possible. Teams must also invest in skilled talent, data scientists, engineers, and marketers who can interpret insights and turn them into actionable strategies. People and technology must operate within a governance framework to manage data quality, security, privacy, and ensure regulatory compliance when handling customer data.

It is important to note that enabling precision marketing is a cross-functional effort. Marketing teams cannot operate in isolation. They must collaborate closely with sales, brands, supply chain, manufacturing, IT, dealer-facing teams, and other applicable functions to ensure that the messaging aligns with the organizational goals of all stakeholder functions. For example, a marketing campaign promoting a new model with a specific trim or feature must be informed by supply chain data to ensure inventory availability in target regions. Without this alignment, even the most sophisticated targeting efforts can backfire and lead to customer frustration and missed opportunities.

In conclusion, precision marketing not only drives higher conversion and retention rates, benefiting automakers, but also enhances customer experience, supports customers with an informed purchasing decision, and contributes to a rich vehicle ownership experience. Precision marketing is crucial for automakers in the current competitive and customer-centric market, and the successful implementation of precision marketing depends on the strategic use of Data Science, AI/ML, and Agentic AI systems.

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Transforming Electric Mobility with **AI for Smarter and Greener Vehicles**

As the world shifts toward cleaner transportation, electric vehicles (EVs) have emerged as a cornerstone of sustainable mobility. Yet, building better EVs is only part of the solution. The real transformation lies in creating an intelligent ecosystem—where vehicles, infrastructure, energy grids, and users operate in seamless harmony. This article explores how Artificial Intelligence (AI) is poised to become the brain of this ecosystem, enabling smarter driving, optimized energy use, and more responsive mobility systems. It also examines the challenges of infrastructure, ethics, and equity that must be addressed to ensure this AI-driven revolution is both responsible and inclusive.

AMITKUMAR SHRIVASTAVA, Fujitsu Fellow & Global Fujitsu Distinguished Engineer

The rise of electric vehicles marks a decisive shift in the global effort to create a cleaner, more sustainable future. But for all the advancements made in battery technology, vehicle design, and charging infrastructure, one truth remains clear. The ecosystem that powers and supports EVs is still far from being truly autonomous or fully optimized for energy efficiency. There is a crucial difference between building better cars and building an integrated, intelligent system where these cars, the energy grid, the road infrastructure, and the user experience work together as a whole.

Artificial Intelligence is at the centre of this transformation. It offers the unique ability to connect the dots where traditional automotive technology falls short. Whether it is predicting traffic patterns, learning driver behaviour, managing battery health, or integrating with renewable energy sources, AI can act as the central nervous system that makes an EV ecosystem not only functional but deeply intelligent.

However, the journey has challenges. As we embrace AI in this space, we must remain mindful of the gaps that exist in infrastructure, data privacy, and public trust. AI's role transcends engineering boundaries, shaping both

societal norms and ethical frameworks. This dual responsibility must guide how the industry moves forward. The question is not whether AI can make the EV ecosystem autonomous and energy-efficient. The real question is how consciously and inclusively this change can be shaped to serve everyone, not just the privileged few.

Where AI Meets Real World Complexity

Autonomous driving is often portrayed as a technological milestone waiting just around the corner. But true autonomy is far more complex than programming a car to stay in its lane or apply brakes when it senses danger. It involves an ongoing, moment-to-moment awareness of the environment that no humanly designed rulebook can fully capture. This is where AI becomes essential.

AI enables the processing of massive amounts of real-time data from traffic flow, weather changes, road conditions and vehicle health. This ability allows EVs to make safe and efficient driving decisions without human input. AI can prevent thermal issues in batteries, optimize routes to save energy and even predict potential mechanical failures before they even happen. These are not futuristic possibilities. They are active areas of development that can change how EVs function in the coming years.

But there is an uncomfortable side to this progress. AI-driven decisions raise difficult ethical questions. In a split-second accident scenario, who or what decides the lesser harm? These are decisions that carry moral weight, yet they are being written into code by developers who may not have clear guidelines or consensus. Until such issues are publicly debated and regulated, complete trust in autonomous EVs will remain out of reach. It is this balance between technical capability and ethical accountability that will define the success of autonomy in the EV space.

Energy Efficiency: Making Every Watt Work Harder

The other great promise of AI lies in energy optimization. Batteries are the heart of an electric vehicle and their lifespan, efficiency and safety determine the true sustainability of EV adoption. AI has the ability to stretch these limits in ways that conventional energy management cannot.

Smarter charging systems that identify low-demand periods to recharge, predictive models that prevent battery degradation, regenerative braking that adapts to terrain and traffic - these are some ways AI can ensure that every unit of energy is used wisely. AI also unlocks the potential for vehicle-to-grid systems, where EVs do not just draw power from the grid but return excess energy to support it. This could change the economics of EV ownership, making cars active contributors to energy stability rather than passive consumers.

But this vision is not yet reality for most users. Charging networks are still fragmented. Grid integration protocols are underdeveloped. There is a genuine risk that these intelligent features will benefit only select urban markets while rural and developing regions are left behind. Without inclusive policy and infrastructure support, the energy optimization potential of AI may deepen existing divides rather than close them. This is a concern that cannot be ignored if the industry wants widespread public acceptance.

Moving Forward with Innovation and Responsibility

There is no doubt that AI holds the key to building an autonomous and energy-optimized EV ecosystem. But technology alone is not the answer. The real measure of progress will be how responsibly and broadly this technology is applied.

Public trust will depend on whether people believe that AI is working in their best interest, not just serving commercial or corporate priorities. This trust must be earned through open standards, clear regulations and honest communication about how AI systems make decisions.

In my view, the future of EVs will belong to those who can marry technical brilliance with social awareness. AI can accelerate this future. But only if its deployment is thoughtful, inclusive and accountable to the larger public good. Otherwise, the dream of a truly autonomous and energy-efficient EV ecosystem will remain confined to the pages of research papers, rather than the roads we travel every day.

Innovations and Developments in **UPS Technology**

As India works toward ambitious energy and carbon reduction goals, energy efficiency has become a national priority across industries and infrastructure. This article explores the often-overlooked role of Uninterruptible Power Supply (UPS) systems in supporting this mission. It highlights how cutting-edge innovations—such as modular designs, silicon carbide semiconductors, smart conversion modes, and real-time monitoring—are transforming modern UPS solutions from simple backup devices into intelligent, sustainable enablers of digital and industrial growth. With a spotlight on **Socomec's** advanced technologies, the article underscores how UPS systems are helping power a more resilient, efficient, and greener India

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Powering a Sustainable India

India is on a mission to reduce energy use by 89 million tonnes of oil equivalent (Mtoe) by 2030. To support this goal, the Bureau of Energy Efficiency (BEE) has introduced a clear plan to improve energy use across industries and buildings. This includes better building codes, energy-saving rules for appliances, and the Perform, Achieve, and Trade (PAT) scheme, which rewards industries that go beyond energy-saving targets. Through the Standards & Labelling programme, appliances are rated for efficiency—helping consumers choose smarter, power-saving products. These steps support India's larger aim to reduce carbon emissions by 45% by 2030 and move toward a more sustainable future.

UPS – A Critical Pillar in Energy Efficiency

One of the lesser-discussed yet vital components of energy-efficient infrastructure is the Uninterruptible Power Supply (UPS). In sectors such as data centres, healthcare, industry, and infrastructure, Socomec's UPS systems combine advanced switching, measurement, energy conversion, and storage technologies. These systems not only ensure power continuity but also contribute to operational sustainability. Beyond backup power, modern UPS systems—especially those developed by Socomec—play a transformative role in energy efficiency. By combining advanced technologies in switching, measurement, energy conversion, and storage, Socomec UPS solutions optimize power usage and reduce energy losses. These systems support scalable, high-efficiency operations with reduced total cost of ownership.

Engineering the Future: Key UPS Innovations

The Uninterruptible Power Supply (UPS) landscape has undergone a transformative evolution, driven by significant advances in design, technology, and materials. Today's UPS systems are not only more efficient and reliable, but also deliver higher performance within a dramatically reduced footprint.

The transformer-free UPS which have become very popular over the past decade eliminates the need for the step-up transformer after the invertor. IGBT (Insulated Gate Bipolar Transistor) technology deal with high voltages to handle high voltages directly, these UPS systems have become smaller, lighter, and more efficient. They also generate less heat, making them easier to manage and more environmentally friendly.

Modular UPS systems are fast replacing traditional monolithic units, as they offer customers the all-important flexibility. Customers can choose the UPS as per the load requirement and then add in extra power modules as and when the need arises. This helps to keep the capital cost under check reducing the threat of wasteful, inefficient oversizing. With Modular UPS systems, floorspace is optimised. What more? It also offers high power density in a compact footprint. Each

power module can be replaced without having to power down the whole UPS and this implies downtime-free maintenance.

More and more UPS manufacturers are moving towards silicon carbide (SiC) semiconductors from traditional silicon based IGBTs. SiC-based UPS units offer significantly higher efficiency, lower electrical resistance, and reduced energy losses. They also deliver improved power density and can run at higher ambient temperatures, while enhancing responsiveness, durability, extended component lifecycles and reduced maintenance requirements.

Modern UPS can communicate with the lower power networks, thanks to the groundbreaking advancements in communications protocols, management and monitoring software, battery technologies. They not only ensure clean, stable power during disturbances but can also feed energy back into the grid, contributing to frequency regulation and grid stability.

An increasingly standard feature in advanced UPS systems is the Smart Conversion Mode, which intelligently balances between online double-conversion and eco-mode operation. This hybrid approach allows the UPS to deliver maximum energy efficiency during normal conditions while automatically switching to full protection mode during disturbances—striking the ideal balance between performance, efficiency, and energy savings.

With such cutting-edge innovations, the modern UPS is no longer just a backup power device—it has become an intelligent, adaptive, and essential component of the digital infrastructure, powering the future with resilience and efficiency.

Socomec at the Forefront: Intelligent, Modular, and Green

Socomec is continuously investing in cutting-edge technology ensuring unmatched UPS longevity and empowering our customers to meet sustainability goals and contribute to a greener future.

The Delphys XL UPS series, known for its 99.1% efficiency via Smart Conversion Mode, embodies Socomec's commitment to sustainability and operational excellence. Its compact design optimizes energy use, while cold-extractible power bricks reduce MTTR (Mean Time Between Failures), crucial for minimizing downtime and reduce the Total Cost of Ownership (TCO) in modern data centres . Advanced features ensure Genset stability during load variations, showcasing reliability. With fault-tolerant design offering double conversion mode redundancy up to 80% of the rated power, it's a critical asset for Tier III & IV data centres, ensuring continuous power supply and mitigates disruptions.

MODULYS XM is Socomec's next-generation modular UPS system, designed for maximum reliability, scalability, and operational efficiency. With a flexible architecture that scales up to 2 MW, it features 50 kW hot-swappable power modules—each independently controlled, with embedded galvanic isolation and third-party certified MTBF exceeding 1,000,000 hours. The system's distributed parallel control eliminates single points of failure, while smart fault isolation ensures that issues in one module do not impact the rest. Maintenance is fast and safe, with full front access and automatic firmware alignment, enabling power modules to be added or replaced in just two minutes. Designed with sustainability in mind, MODULYS XM supports a variety of battery technologies (VRLA, Li-ion, Ni-Cd), features eco-friendly components, and enables remote diagnostics to reduce carbon emissions. With compliance to international standards and parallel capability up to 2 MW, MODULYS XM is the ideal solution for data centres, healthcare, infrastructure, and industrial applications.

Another high-performance offering from Socomec, the DELPHYS XM, is a high power-density UPS solution delivering superior efficiency and compliance with EN/IEC 62040-1, EN/IEC 62040-2, and EN/IEC 62040-3 standards. Available in capacities ranging from 300 to 800 kVA/kW, DELPHYS XM is tailored for data centres, commercial buildings, and industry-light environments, enabling enterprises to meet their sustainability and efficiency objectives with confidence.

Socomec's free mobile App, SoLive, automatically reports the current status of the UPS, providing instant notification of

any event. Alternatively, Socomec experts also provide 24/7 monitoring and send a technician to location if necessary for ensuring customer's peace of mind.

In the evolving electrical sector, cutting-edge technologies such as IoT and remote monitoring are reshaping industry dynamics. These digital enablers support predictive maintenance, optimize operational efficiency, and enhance overall productivity across sectors. Moreover, we foresee that as India advances in industrial growth, green manufacturing emerges not just as a strategy but as an imperative.

Enhancing Efficiency through Digital Tools & Monitoring

The massive digitalisation means increased data that needs to be available on demand. This in turn has given rise to the need for continuous power supply and uninterrupted power even in case of power disruptions. Massive digitalisations have amplified the potential impact of cyberattacks and using UPS systems can help buffer unpredictable power disruptions. Recognizing this, Socomec integrates robust cybersecurity protocols into its digital UPS platforms. With secure data encryption, role-based access controls, and regular firmware updates, we ensure the integrity of communications and system operations.

Conclusion: A Smarter, Greener Grid with Socomec

Thanks to major advancements in communication protocols, monitoring software, and battery technology, modern UPS systems can now interact directly with local power grids. In line with environmental goals, Socomec ensures compliance with RoHS and WEEE directives and designs its systems for easy disassembly and recycling at end-of-life. Compatible with next-generation battery chemistries, Socomec's UPS systems are future-ready and engineered for minimal ecological impact. Depending on real-time load conditions, they can draw electricity from the grid or feed stored energy back into it, helping to balance demand and supply while maintaining grid stability.

Empowering the Digital Age: Resilience through UPS

As a global leader in power management, Socomec is dedicated to meet these evolving energy needs by manufacturing eco-design products in India, prioritizing environmental sustainability to provide innovative solutions that help organizations minimize their carbon footprint and achieve resilience goals. The adoption of sustainable practices offers not only economic resilience and global competitiveness but also underscores a commitment to environmental stewardship.

Also keeping in pace with today's digital landscape, Socomec's investments will also be promptly made in developing adequate technology that supports uninterrupted power supply, connectivity, and a wide array of digital services. The adoption of advanced technologies minimizes downtime, reduces wastage, and enhances operational efficiency, resulting in overall cost reduction for electrical infrastructure.

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Empowering the EV Revolution:

Transforming EV Logistics with Smart Fleet Platforms and Multi-Use Chargers

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As India accelerates its transition to electric mobility, the electrification of commercial fleets stands out as a major driver of sustainable logistics. Central to this transformation are intelligent fleet management platforms and multi-application EV chargers, which are redefining how electric vehicles are deployed, charged, and maintained. This article explores how these technologies, along with integrated energy systems, are powering a smarter, cleaner, and more efficient mobility ecosystem.

Accelerating the Shift Toward Electric Mobility

India is swiftly transforming its transport sector to cut carbon emissions, reduce oil dependence, and meet global climate commitments. A critical enabler of this transition is the electrification of the mobility sector; a space the government is putting its shift on the table with policy moves and ambitious targets for the same. Some of the goals are to reach 30% Electric Vehicle (EV) penetration by 2030, which would make a clear statement that India is going to take the lead in sustainable mobility.

Recent data from FY 2024-25 point to the increasing popularity of electric cars. There were records of over 1.14 million units of e-2Ws being sold – an increase of 21% Y-o-Y. Electric three-wheeler (e-3W) sales also registered a 57 per cent jump to 159,235 units. These numbers represent a developed consumer demand for clean mobility and a big step towards mass electrification.

Key to this expansion is the government's PM Electric Drive Revolution in Innovative Vehicle Enhancement (PM E-DRIVE) initiative. With an expenditure of ₹10,900 crore over two years and a strong emphasis on demand incentives, local manufacturing, and infrastructure development, the scheme has reportedly gained rapid momentum. This program not only enhances the affordability and accessibility of E Vs but also paves the way for India's transport system to leapfrog into an environmentally cleaner, greener future.

A Catalyst for Decarbonizing Logistics and Public Transport

While individual EVs help, the real game-changer lies in electrifying commercial fleets. High-utilization fleets like e-commerce, logistics, and public transport are major contributors to emissions when using internal combustion engines. Diesel trucks, though just 3% of India's fleet, account for 53% of particulate matter and one-third of transport-related CO_2 emissions. A shift to zero-emission trucks (ZETs) could save 2.8–3.8 gigatons of CO_2 by 2050. Additionally, ZET adoption could reduce diesel consumption by 838 billion liters, saving ₹116 lakh crore (US$1.5 trillion) in oil costs. This transition supports both emission reduction and India's broader sustainability goals.

But to some extent, that is already beginning to change, as many companies are now making the shift to electric fleets, not just to meet internal sustainability goals, but because they want to avoid

skyrocketing costs for fuel and vehicle maintenance. For instance, big online stores and delivery aggregators are deploying electric two- and three-wheelers for city deliveries, and city transit authorities are investing in electric buses to provide cleaner public transportation.

The Indian State has made many efforts in this direction. There is a separate allocation of ₹4,391 crore only for fleet electrification in public transport under the PM Electric Drive Revolution in Innovative Vehicle Ecosystem (PM E-DRIVE) scheme. The aim of this funding is to assist the state and city-level transport departments to buy 14, 028 electric buses in the country. The scheme will also drive the growth of charging infrastructure, and the manufacture of batteries, packs, and cells in the country, serving the dual purpose of environmental as well as economic prosperity.

India is well-positioned to lead the transformation of its transportation sector through the electrification of public and commercial fleets. This transition presents a powerful opportunity to enhance urban air quality, strengthen energy security by promoting domestic energy sources, and build a cost-effective, technology-driven, and future-ready transportation network. Embracing this path supports the nation's ambitious goals for smart and sustainable cities, reinforcing its commitment to innovation, environmental stewardship, and long-term economic growth.

Intelligent Fleet Management Platforms and Multi-Application EV Chargers

There are two key components that are necessary for the successful deployment of electric vehicles in commercial fleets.

- **Intelligent Fleet Management Platforms:** These are based on IoT, cloud analytics, predictive preventive maintenance to optimize fleet operations, tracking vehicle performances, and scheduling the charging of vehicles.
- **Multi-Application EV Chargers:** The smart multi-standard charging system to charge different types of vehicles such as two-wheeler, three-wheelers, four-wheelers and buses at a common platform.

The Challenge: Electrifying Fleets at Scale

While mass electrification of the fleet holds significant promise, there are some particular and potentially unique challenges associated with scale that must be addressed to ensure the reliability, affordability, and operational performance of the service.

High Utilization Requirements

Most commercial fleets are in consistent use, sometimes around the clock maintaining busy schedules with little down time. For instance, delivery fleets are carrying out multiple shifts, and buses have to stick to a schedule. In such situations, charging disrupts or unexpected maintenance can have a serious effect on a company's operations and customer service

Charging Downtime

Traditional charging setups are not always designed for the fast-paced nature of commercial operations. Extended duration of charging may restrict vehicle availability from time yet limit daily availability and thereby affect daily service capacity and thereby reduce revenue. The situation is more complex if there are more vehicles that must be charged at once, and there is a need for fast-charging methods as well as charging windows that meet the operation needs.

Infrastructure Compatibility Across Vehicle Types

A fleet can be composed of various kinds of EV models, which are equipped with diverse battery sizes (capacities), voltage and connector types. Dealing with this profile of uncertainty in the absence of a common charging direction may generate system inefficiencies and additional investment requirements. These incompatibilities can lead to time-consuming operational delays, not to mention investments in multiple charger types, space and management systems.

Managing Energy Demand and Cost

Massive charging may have a great influence on the demand of power. Especially for a simultaneous charging situation. This not only puts pressure on the local grid but also means that fleet operators are paying more for electricity during periods of peak demand. Without a smart energy management approach, fleets may cause high operating expenses while destabilizing the local energy supply.

Need for Real-Time Monitoring, Scheduling, and Energy Optimization

Fleet electrification needs to be based on data. Operators will have insight to the location of the vehicle, battery status, and charging, as well as energy consumption in real-time. With built-in scheduling features, charging windows can be set according to usage patterns and energy charges to make sure vehicles are always charging and ready—without overcharging the bill. Reliability is increased through the use of predictive analytics, which can help determine maintenance before machines fail.

The Solution: Fleet Management Platforms

With increased adoption of Electric Vehicles (EVs) into commercial fleets, the efficient operation of such fleets is of paramount interest. For such needs, integrated fleet management platforms offer fleet operators a central one-stop-shop to manage and optimize their operations in a very visual manner. These are advanced technology platforms that deliver the electricity fleets need to keep rolling, minimize downtime and optimize performance.

Integrated Software Platforms

Fleet management platforms provide powerful capabilities that consolidate control, visibility, and action for a disparate fleet of EVs. These platforms enable fleet operators to:

- **Real-Time Monitoring:** Fleet managers monitor vehicle's exact location, battery's status, the progress of charging and all sort of important stats in real-time. This exposure allows operators to address issues in a timely manner and make routing and vehicle deployment decisions based on the real- time information
- **Predictive Maintenance:** These solutions can predict maintenance needs before they are necessary, leveraging data analytics. This pro-active strategy cuts down on spontaneous breakdowns, makes

for less costly repairs, and can lead to more time on the road. For instance, it could identify problems like battery deterioration or motor degradation and enable early intervention

- **Optimized Scheduling:** Fleet management platforms optimize vehicle charging to maximize the incidents when vehicles are available for use. And by incorporating vehicle usage patterns with the current state of charge, these platforms minimize charging time, reduces inoperable vehicles, and guaranteed no bus is ever out of service due to dead batteries

Importance of IoT, Cloud Analytics, and Predictive Maintenance

A vital component supporting these fleet management functions is the use of IoT (Internet of Things) devices for the continuous, real-time measurement of vehicle and charge station data. These IoT devices monitor critical data points such as

- **Battery charge levels**
- **Vehicle speed and performance**
- **Energy consumption during travel**
- **Charging station availability and energy output**

Once that data is collected, cloud analytics will process it into insights that can be used. This real-time capability also allows the operators to 'convert' into smart deciders being able to decide over the changing of a route due to traffic jams or re-reoptimizing the charging schedule to take advantage of the cheapest power availability.

Moreover, predictive maintenance algorithms significantly decrease downtime and enhance the performance of the fleet. The algorithms sift through historical and real-time data, so that a vehicle can get work when it's starting to need it, helping operators avoid breakdowns and minimize service interruptions. For example, predictive maintenance can tell you when a vehicle's battery will run out of steam, or when certain parts – tires or motors for instance – might need replacing.

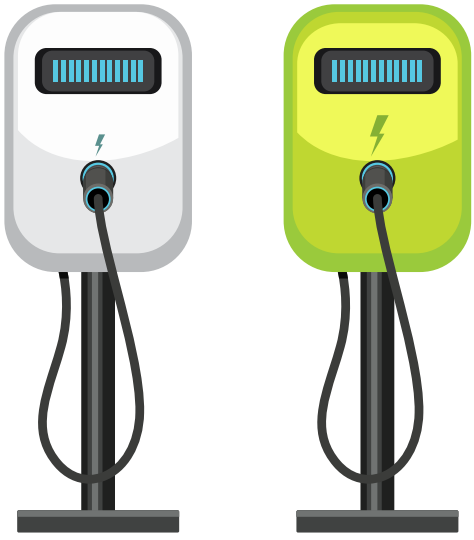
Delta's Capabilities in Automation and Smart Energy Systems Integration

Delta Electronics, a leader in automation and energy management, provides fleet operators with cutting-edge solutions to integrate automation, energy management, and smart charging infrastructure. Delta's fleet management platforms combine:

- **Energy-efficient Automation:** Delta offers solutions that assist in the automation of important tasks, including charging station management and fleet management, thereby minimizing human intervention and enhancing operational performance.
- **Smart Charging Infrastructure:** Delta combines smart charging technology with an advanced energy management system which allows for optimizing the charge time considering the grid, energy price, and fleet schedule.
- **Comprehensive Energy Management:** Delta platform features energy management that reduces wasted energy and operational costs, and ensures fleets always have enough power for operations. Such integration allows controlling the energy consumption and prevents overloading of the grid in rush hours.

Through its innovative solutions, Delta provides fleet operators with the tools to optimize fleet operations while maintaining a focus on sustainability and efficiency.

Infrastructure Optimization Through Integration



Combining EV charging infrastructure with advanced energy technologies is an important part of creating a resilient, affordable, and clean mobility system. The use of solar power, battery energy storage system (BESS) and the implementation of intelligent energy management platforms like SCADA and EMS are the most effective strategies.

Combining Charging with Renewables (Solar PV):

When combined with EV charging infrastructure, solar photovoltaic (PV) systems can allow fleet operators and facilities managers to gain independence from the grid. Solar panels convert sunlight into electricity, which can be used directly to charge EVs during the day. That's not only reducing electricity costs but also reducing the carbon footprint of the whole business. Solar can be a clean and cost-effective solution for fleet depots, destination charging spots, or remote charging stations at commercial hubs, particularly when complemented with smart inverters and monitoring platforms that can optimize solar yield.

Energy Storage Systems (BESS):

Battery Energy Storage Systems support solar PV by storing extra energy produced in solar peak or off grid peak. This stored energy can later be deployed during times of low solar production, or when there is high demand for electricity (like at night or during peak operating times). BESS also enables a stable power supply, lowers demand charges, and offers backup power in the event of an outage. For large EV fleets needing high-energy capacity, BESS flattens load curves and enhances energy resiliency.

SCADA/EMS Platforms:

Supervisory Control and Data Acquisition (SCADA) and Energy Management Systems (EMS) play a critical role in optimizing energy use across integrated systems. They also enable monitoring, prediction and centralized management of energy generation, storage and usage, in real time. SCADA permits operators to monitor the performance of individual devices such as solar inverters, battery modules, and EV chargers, whereas EMS enables automatic decision making in load balancing, renewable utilization, and price-response. When used together, they are said to improve performance, identify faults from a proactive stance, and expedite interaction with the more intelligent grid.

Integrating these technologies into EV infrastructure not only secures the grid and contributes to energy costs savings, but also drives toward the goal of decarbonized and self-powered mobility. By offering smart grid-compatible designs with integrated solar generation, energy storage, and intelligent energy management, these solutions enable the deployment of future-proof EV charging infrastructure tailored for fleet managers and energy infrastructure developers.

Conclusion

The transition to electric mobility is far more complex than merely replacing internal combustion engine vehicles with electric alternatives. This takes more than just accommodating EV deployment; instead, we need to build an intelligent and integrated ecosystem that guarantees efficient EV operation for a range of use cases, particularly for demanding applications such as logistics and public transportation. At the core of this ecosystem are intelligent fleet management solutions and multi-application EV chargers. These technologies are key to helping operations work more efficiently, reducing energy consumption, and lessening the impact of downtime on the planet.

IOT, AI and cloud analytics enhanced fleet management platforms make real-time analytics, predictive maintenance, and intelligent scheduling possible, all of which is key for the effective deployment of commercial EVs. Multi-application chargers, meanwhile, offer the potential to charge a mix of vehicles, from two-wheelers to electric buses, all off a single infrastructure network, streamlining logistics and reducing infrastructure costs.

Indian Engines Meet Japanese Precision: A New Era in Clean Power

When Indian engines meet Japanese precision, innovation takes on a new dimension. The launch of the Daimon Genset, India's first CPCB IV+ certified 10 kVA LPG genset, marks a significant milestone in sustainable power solutions. Developed through a strategic partnership between two centurions, **Cooper Corporation and Sinfonia Technology,** this compact yet powerful genset reflects engineering excellence on both sides. Built for performance, efficiency, and environmental responsibility, it's designed to serve both Indian and global markets.

Cooper Corporation has recently announced a landmark strategic partnership with Japan's Sinfonia Technology. This significant alliance unites over two centuries of collective engineering expertise, rich legacy, and a shared commitment to driving innovation in the clean energy space.

The visionary collaboration was formalized with the launch of the 'Daimon Genset,' India's first CPCB IV+ certified 10 kVA LPG genset. Setting a new standard in efficient and sustainable power generation, the genset will be exclusively manufactured by Cooper Corporation. It will be jointly marketed across India and exported worldwide, underscoring both companies' steadfast commitment to technological innovation, energy efficiency, and environmental responsibility.

The COOPER SINFONIA genset, model CSG-0010L-IN, will be marketed in India under the brand name 'DAIMON,' named after the town that houses Sinfonia Technology's headquarters. In Japan, it will be sold under the brand name 'SATARA,' honoring the historic town that has been Cooper Corporation's home for over a century. This innovative genset delivers exceptional performance, cost-efficiency, and reliability, featuring a compact design, low operational costs, and easy maintenance. It presents a superior, cost-effective alternative to traditional diesel gensets and grid power. Powered by LPG, a clean and sustainable fuel, the Daimon Genset minimizes environmental impact while optimizing energy efficiency.

Mr Farrokh N. Cooper, Chairman & Managing Director, Cooper Corporation Pvt. Ltd., shared his vision for the strategic partnership, stating, "This partnership with Sinfonia Technology marks a purposeful step towards reshaping the energy landscape with cleaner, smarter solutions. The Daimon Genset reflects our belief that progress is driven by collaboration where Japanese precision and Indian engineering come together with intent. With CPCB IV Plus compliant, high-efficiency LPG gensets, we aim to help industries transition to sustainable and cost-effective power solutions without compromising on reliability or performance.

Mr Makoto Saito, General Manager of Social Infrastructure System Sales Dept., Sinfonia Technology Co. Ltd. added, "Our collaboration with Cooper Corporation underscores our shared vision of delivering sustainable, high-efficiency power solutions worldwide. The Daimon Genset combines Japanese precision engineering with India's manufacturing prowess, creating a product that meets the highest international standards. Through this collaboration, we are proud to push the boundaries of clean energy accessibility and drive meaningful progress toward a greener future."

The 10 kVA LPG - Daimon Genset, fully adheres to the Central Pollution Control Board IV+ (CPCB IV+) norms—India's most stringent emission standards aimed at curbing air pollution and advancing sustainable energy solutions. Representing a new standard in environmental performance, fuel efficiency, and cutting-edge engineering, the genset is powered by Cooper's indigenously developed lean-burn gas engine, created in collaboration with Ricardo, UK. It features an Electronic Engine Management System, Isochronous Governing, and a compact V-Twin 2-Cylinder engine, delivering reduced emissions, ultra-quiet operation, high power density, and a lightweight, space-saving design—making it well-suited for a wide range of applications in both urban and rural settings, including microgrids, educational institutions, retail

outlets, and industrial facilities.

As part of this strategic partnership, Cooper Corporation will manufacture the gensets at its advanced facility in Satara, Maharashtra. The product will be jointly marketed and distributed by both partners across India and global markets, with a targeted focus on Asia, Africa, and the Middle East. Backed by over a century of engineering legacy, Sinfonia Technology brings deep expertise in power electronics and robust international market reach—further reinforcing the alliance's capability to deliver world-class clean energy solutions tailored to the needs of a rapidly evolving sustainable future.

An Exclusive Interview with Mr Cooper and Mr Hiroharu Senju, Director, Sinfonia Technology Co. Ltd., Japan was conducted during the Daimon Genset launch

A Partnership Rooted in Mutual Strengths

The collaboration between Cooper Corporation and Japan's Sinfonia Technology began with shared intent and complementary capabilities.

Mr Cooper shared, "Sinfonia is a very reputed company in Japan, listed as a Prime Member of the Japanese stock exchange. They're a large multinational with diverse operations. They approached us with an interest in developing gas engines together. They saw value in our engines, and we saw value in what they could offer. So we collaborated, developed a product, and sent it to Japan. It was approved there, and now we're selling it in India."

From Sinfonia's side, the focus was on leveraging their technological strengths to support clean energy initiatives in India. Mr Hiroharu Senju explained that, "Sinfonia Technology is actively working on clean energy solutions in Japan, including the use of ammonia, hydrogen, and LNG (liquefied natural gas). These energy sources are being considered for gensets and other applications. With this in mind, we're looking to collaborate with Cooper Corporation to expand into the Indian market."

Bringing Complementary Engineering Expertise Together

At the heart of this collaboration is a well-balanced division of strengths—engines from Cooper and alternator expertise from Sinfonia.

Mr Senju elaborated, "Our core strength at Sinfonia lies in alternators, especially those used in generators. In a typical generator setup, you have an engine and an alternator—the engine drives the alternator, which produces electricity. Sinfonia has deep expertise in alternators, particularly for high-capacity generators, and we aim to bring this technology into the Indian market."

Mr Cooper emphasized the importance of engine design from the ground up, he said, "Our engines, designed by Ricardo, have a clear advantage—these aren't retrofitted engines. They are designed and built from the ground up as gas engines. In fact, this is the only LPG engine certified under the CPCB IV+ norms. No other company currently offers this."

Designed by Intent: Efficiency at the Core

This collaboration stands out for creating a gas engine not as an afterthought, but as a fundamental design objective. Mr Cooper noted that, "When you design an engine specifically for gas or diesel, you integrate it into the core architecture of the engine. It's not about converting or retrofitting—it's designed by intent. That gives you optimal fuel efficiency, power, reliability, and durability."

Compact, Powerful, and Built for the Future

One of the standout engineering features is the V-Twin engine design, which offers both form and function.

Mr Cooper explained, "This is a V-Twin engine, while most of the competition uses a three-cylinder setup. Our two-

cylinder engine is more compact, lighter, and more efficient—almost like a high-performance motorcycle engine. It has fewer components, less weight, and requires less maintenance."

Tested and Approved: From Japan to India

Early feedback from both Indian and Japanese markets has validated the genset's potential.

Mr Cooper shared, "We've received very positive feedback from early adopters. One sample was sent to Japan, they liked it, and that's what encouraged us to move forward. While the engine is ours, the other components—like the canopy and electrical systems—were developed jointly. Sinfonia contributed to those elements, including making the product compatible with both 50 Hz and 60 Hz frequencies. That's another unique aspect—this genset works seamlessly on both."

Mr Senju added further detail on Japan-specific customizations, he said, "In our collaboration with Cooper, we're not just developing the Indian model—we're also working on a version tailored for Japan, which involves unique challenges. For example, in Japan, unlike India, the grid voltage is 100 volts, and the frequency varies between 50 Hz and 60 Hz depending on the region. We need gensets that can switch frequencies depending on the location. So, we're working with Cooper to ensure the genset runs on both 50 Hz and 60 Hz—a feature that's not required in India but is critical in Japan."

Meeting Tough Regulatory Norms

Japan's strict certification requirements also shaped the development process.

Mr Senju shared, "We also face strict regulatory requirements in Japan—for example, our gensets must be capable of running continuously for 72 hours. We're collaborating closely with Cooper to meet these requirements and successfully adapt the technology for our market."

A Long-Term Vision for Clean Energy

While the LPG genset is the first offering from this partnership, both companies see it as just the beginning.

Mr Senju said, "Looking ahead, we see this LPG genset as just the first step in a long-term partnership. Over the next five to ten years, we plan to expand into cleaner fuels like natural gas, ammonia, and ultimately hydrogen. Our shared goal is to move towards zero-emission energy solutions. We're very excited about this journey with Cooper Corporation and look forward to what we can achieve together."

Mr Cooper echoed this ambition while touching on the distribution model, he added, "We've also partnered with HPCL to distribute the genset through their outlets."

This collaborative venture between Cooper Corporation and Sinfonia Technology represents a unique fusion of Indian engine design and Japanese electrical and systems expertise—built for both local needs and global aspirations..

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