

Daily Editorial Analysis 4 February 2026

February 4, 2026 • vajiramandravi.com

India's Next Industrial Shift — Electrons Over Molecules

Context

- For more than a century, **industrial** growth has been driven by the combustion of fossil fuels. Coal, oil, and gas supplied heat and motion through **molecules**, shaping factories, transport systems, and global trade.
- This paradigm is now being replaced by one centred on **electrons**, delivered through electricity networks.
- The shift toward **electrification** is no longer only an environmental objective; it is a defining factor in economic **competitiveness**, trade access, and resilience.
- Countries that rapidly electrify production, particularly with clean power, are better positioned to attract capital and jobs. In this emerging landscape, **China** has moved decisively ahead, while **India** faces a pivotal moment in determining its industrial future.

Conceptual Framework: Molecules versus Electrons

- The contrast between molecules and electrons offers a clear framework for understanding the energy transition.
- Molecules such as coal, oil, and gas are burned directly in engines, furnaces, and boilers. Electrons, supplied through the **grid**, power electric motors and digitally controlled processes.
- Electrification delivers significant **efficiency** gains: electric motors convert over 90% of energy into useful work, compared with less than 35% for combustion engines.
- These gains enable higher **automation**, better process control, and faster **decarbonisation** as electricity generation shifts toward cleaner sources.
- As a result, each incremental increase in electrification displaces a disproportionately large amount of fossil fuel use.

China's Electron-First Industrial Strategy

- China's approach demonstrates how electrification can be used as a deliberate industrial **strategy**.
- Nearly half of its industrial energy consumption now comes from electricity, with a growing share sourced from **renewables**.
- This transformation has been enabled by sustained **investment** in generation capacity, ultra-high-voltage transmission, flexible substations, and grid-scale storage.
- Rather than relying on on-site fuel combustion, factories are designed to run on reliable grid power.

- Sectoral outcomes illustrate this shift. In **steel** production, electric arc furnaces have expanded rapidly through policies supporting scrap recycling and preferential electricity tariffs.
- In **cement**, electrification of grinding, materials handling, and advanced controls has reduced fuel intensity, while waste heat recovery supplies a meaningful share of energy demand.
- Although process emissions remain unavoidable, pilots for carbon capture indicate long-term planning.
- Together, these measures strengthen **manufacturing** competitiveness in markets where carbon intensity increasingly influences trade decisions.

India's Starting Point and Structural Constraints

- India has expanded electricity capacity rapidly and is a global leader in annual solar additions.
- Despite this progress, industrial electricity accounts for only about one quarter of energy use, while green electricity remains a small fraction of final demand.
- Three structural constraints explain this gap. First, legacy reliance on on-site combustion continues to lock firms into molecule-based systems. Second, uneven power quality discourages all-electric process design.
- Third, **policy** has prioritised generation capacity more than industrial adoption of electricity.
- Without addressing these constraints, Indian industry risks falling behind as global markets tighten carbon standards.

Sectoral Pathways for India's Transition

- India nevertheless has viable pathways to accelerate the **transition**. Around one-third of steel production already uses electric arc furnaces, providing a foundation for expansion.
- Improving scrap collection and linking incentives to clean power could raise this share, particularly as the European Union's **CBAM** reshapes global trade.
- In cement, support for electrified kilns, large-scale waste heat recovery, and carbon capture hubs could significantly reduce fuel use per tonne over the coming decade.
- For **MSMEs**, which often depend on coal boilers and diesel generators, the challenge is access rather than technology.
- Concessional finance for electric boilers, pooled procurement of renewable power, and technical assistance are essential.
- Embedding **digitalisation** in new industrial clusters can further reduce energy waste, enable demand response, and generate auditable emissions data demanded by international buyers.

Strategic Importance Beyond Climate Goals

- The shift from molecules to electrons extends beyond climate mitigation. Low-carbon production is increasingly central to **exports**, influencing buyer preferences and supply-chain contracts.
- Electrification enhances energy **security** by reducing exposure to volatile imported fuel prices.
- It also strengthens economic **sovereignty**, allowing industries to locate based on skills and logistics rather than proximity to fossil fuel resources.

Conclusion

- The emerging industrial race is defined by the speed and **quality of electrification**.
- China's experience shows that directing clean electricity into industry delivers durable advantages in productivity and trade. India must respond with equal ambition.
- Future efforts must focus not only on adding capacity but on ensuring that electricity flows into factories, workshops, and industrial parks.
- Accelerated grid investment, mandated electrification in new clusters, and targeted support for smaller firms are critical.
- The next phase of **global industry will be written in electrons** rather than molecules, and India's ability to compete will depend on how decisively it acts now.

India's Next Industrial Shift — Electrons Over Molecules FAQs

Q1. What does the shift from molecules to electrons signify in modern industry?

Ans. It signifies a transition from direct fossil fuel combustion to electricity-driven production that improves efficiency, automation, and decarbonisation.

Q2. Why does electrification improve industrial energy efficiency?

Ans. Electrification improves efficiency because electric motors convert over 90% of input energy into useful work, far more than combustion engines.

Q3. How has China used electrification to strengthen manufacturing competitiveness?

Ans. China has invested heavily in grid infrastructure and clean electricity to redesign industrial processes around reliable, low-carbon power.

Q4. What are the main structural constraints limiting India's industrial electrification?

Ans. India faces legacy dependence on fossil fuels, uneven power quality, and policies that focus more on generation than industrial adoption.

Q5. Why is industrial electrification important beyond climate change goals?

Ans. Industrial electrification enhances export competitiveness, improves energy security, and strengthens economic sovereignty.

Source: **The Hindu**

AI's Next Investment Cycle Belongs to Applications

Context

- The **artificial intelligence** industry has entered a critical phase. After years of rapid expansion and heavy capital deployment, the central issue has shifted from technical capability to long-term **profitability**.
- Massive spending on compute power, data centres and foundational systems has proven that AI can function at scale, but not that it can consistently generate profits.
- The emerging evidence shows that durable value is being created not at the level of **infrastructure**, but through practical AI **applications** that solve real business problems.

The Limits of Infrastructure-Led Growth and The Rise of AI Applications and Real Demand

• The Limits of Infrastructure-Led Growth

- The AI sector has been shaped by unprecedented **investment** in infrastructure, reaching hundreds of billions of dollars annually.
- Despite this scale, foundational AI providers continue to struggle financially. Operating **margins** remain thin due to high **inference** costs and intense **competition** among model providers, which suppresses pricing power.
- Even firms reporting strong revenue growth often remain unprofitable, relying on external funding to offset operational losses.
- A further weakness of this model is the prevalence of circular spending. Much reported revenue originates within the AI ecosystem itself, particularly through discounted compute arrangements between large technology firms.
- This dynamic inflates revenue figures while masking limited external **demand**, raising concerns about the sustainability of infrastructure-driven growth.

• The Rise of AI Applications and Real Demand

- In contrast, AI applications show clear signs of genuine market traction.
- Corporate spending on applied AI tools has grown rapidly, reflecting widespread **adoption** rather than experimentation.
- These tools are increasingly embedded in daily operations across industries, driving efficiency and cost savings.
- The commercial success of application-focused companies is evident in their recurring **revenue**, with multiple products reaching substantial annual income levels within a short time frame.
- This performance demonstrates that customers are willing to pay for AI systems that deliver concrete outcomes, validating application-led business models and highlighting the limits of purely technological differentiation.

Investment Shifts and Market Validation

- Market behaviour among **investors** further confirms this shift. Capital is increasingly flowing toward AI firms with proven products, stable customers and clear paths to profitability.
- Strategic **acquisitions** now focus on application providers rather than infrastructure assets, reflecting confidence in businesses that offer immediate operational value.
- High-profile purchases of young but revenue-generating AI companies illustrate this trend.
- These deals reward speed to market, usability and customer relevance, reinforcing the idea that successful AI strategies prioritise execution over scale alone.

Departmental AI and the Concentration of Value

- The strongest concentration of AI value is found in **departmental** AI tools, particularly those designed for **coding**.
- These applications represent the largest share of departmental AI spending and enjoy exceptionally high daily usage rates among developers.
- Their success is driven by clear gains in **productivity**, making their value immediately measurable.
- Large technology firms have responded by acquiring application-focused startups that enhance employee efficiency and automate routine tasks.
- These transactions underline the growing consensus that AI's economic contribution is maximised when tools are tightly aligned with specific job functions.

Applications as the Driver of Model Success

- Shifts within the **enterprise** AI market further support the primacy of applications.
- Changes in market share among leading **models** have been driven less by technical superiority and more by dominance in high-value use cases such as software development.
- This demonstrates that applications generate demand for underlying models, reversing the assumption that better models naturally lead to better businesses.
- As AI systems mature, the greatest returns accrue to companies offering integrated solutions rather than standalone model access.
- Deep **integration** into organisational **workflows** creates switching costs and long-term customer dependence, strengthening profitability over time.

Policy and Regulatory Challenges

- The expansion of AI applications raises complex policy questions.
- As large AI providers move downstream into applications, competition risks intensify, potentially disadvantaging smaller innovators.
- At the same time, AI solutions tailored to specific **verticals** increase exposure to legal issues around data use, **privacy** and accountability.
- Effective **regulation** must balance oversight with flexibility. Overly restrictive rules could suppress experimentation, while weak enforcement may allow dominant firms to stifle competition.
- The goal should be to preserve market openness while protecting users and maintaining trust.

Conclusion

- The evolution of AI mirrors earlier technological revolutions.
- Just as the Internet derived its value from services built on top of connectivity, AI will be monetised through applications that convert computational power into business results.
- Infrastructure enables progress, but applications deliver **innovation** and lasting economic **impact**.
- As capital markets and policymakers refocus on fundamentals, the future of AI is increasingly defined by usefulness, integration and real-world outcomes rather than scale alone.

AI's Next Investment Cycle Belongs to Applications FAQs

Q1. Why is AI infrastructure alone no longer sufficient for long-term success?

Ans. AI infrastructure alone is insufficient because high costs and competition prevent it from achieving sustainable profitability.

Q2. What indicates that AI applications have real market demand?

Ans. Strong customer adoption and high recurring revenues show that AI applications meet real business needs.

Q3. Why are investors shifting focus toward AI applications?

Ans. Investors prefer AI applications because they generate measurable value, stable revenues, and clearer paths to profitability.

Q4. Which area of AI applications shows the strongest value creation?

Ans. Departmental AI, especially coding tools, shows the strongest value creation due to direct productivity gains.

Q5. What regulatory challenge arises as AI companies expand into applications?

Ans. Competition concerns increase as large AI providers may disadvantage smaller firms by controlling both models and applications.

Source: **The Hindu**

Source: <https://vajiramandravi.com/current-affairs/daily-editorial-analysis-4-february-2026/>

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