

Technologies For *Viksit Bharat*: A Pathway to Inclusive and Sustainable Development

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ABSTRACT

The vision of *Viksit Bharat 2047* represents an ambitious, transformative agenda to evolve India into a developed, equitable, and sustainable nation by the centenary of its independence. Central to this vision is technology - not just as a catalyst for growth but as a driver of inclusion, empowerment, and resilience. This paper critically analyzes the pivotal technological arenas enabling this journey, ranging from digital infrastructure to advanced manufacturing and biotechnology. By juxtaposing flagship initiatives with emerging innovations, and examining systemic challenges, the study offers a comprehensive roadmap for realizing this vision through participatory and scalable tech solutions.

Keywords: *Viksit Bharat, Innovations, Technology*

INTRODUCTION

The *Viksit Bharat 2047* agenda is India's strategic response to global megatrends—climate change, digital disruption, and demographic shifts. The concept of *Viksit Bharat* involves not just economic advancement but also equitable social development and ecological balance. It imagines a country that is not only economically strong but also environmentally conscious, socially inclusive, and geopolitically influential. At the heart of this transformation lies technology: a multi-dimensional enabler that

spans governance, livelihood creation, healthcare access, environmental resilience, and industrial competitiveness (NITI Aayog, 2023; MeitY, 2023). By aligning with the United Nations Sustainable Development Goals (SDGs), India aims to bridge legacy gaps while leapfrogging into future-ready domains like AI, renewable energy, and smart manufacturing. India is entering a pivotal phase in its developmental journey. With aspirations to become a \$10 trillion economy by 2047, there is a strategic emphasis on embedding technology across governance, industry, and public welfare. This paper reviews emerging technologies and their role in accelerating this transformation, focusing on digital empowerment, renewable energy, AI-driven solutions, healthcare innovation, and modernized agriculture and manufacturing systems. The synergistic effect of these domains requires collaborative action among policymakers, industry, academia, and civil society.

Digital Infrastructure and Connectivity
India's digital revolution has been catalyzed by initiatives such as *Digital India* and *Bharat Net*, with over 1.7 lakh gram panchayats now digitally connected (Ministry of Communications, 2023). The *PM-WANI* initiative's deployment of more than 200,000 public Wi-Fi hotspots (TRAI, 2023) and the *India Stack* (Mehta & Kapoor, 2022; NPCI, 2024)—which includes Aadhaar, UPI, Digi Locker, and ONDC—has streamlined public services and ensured

digital public infrastructure reaches over 600 million rural residents.

Artificial Intelligence and Automation

India's AI ecosystem is valued at USD 7.8 billion, with over 5,000 startups contributing across sectors such as healthcare, education, and agriculture (NASSCOM, 2024). Social-good applications like Qure.ai and Niramai have enabled over 10 million screenings in rural settings (NITI Aayog, 2023). Meanwhile, the *National AI Resource Platform (NAIRP)* has trained more than 1.2 million people in AI and data science (MeitY, 2023). Projects like *AI4Bharat* promote inclusive NLP tools in Indian languages (Kunchukuttan et al., 2021).

Table 1 AI Adoption in Sectors (2023)

Sector	Adoption Rate (%)
Healthcare	45%
Agriculture	33%
Education	25%
Governance	18%

(Source: NITI Aayog, 2023)

Renewable Energy and Green Technologies
India is focusing on clean energy as a cornerstone of sustainable development. As of 2023, renewable energy accounts for over 170 GW of installed capacity. The government aims to reach 500 GW of non-fossil fuel capacity by 2030. Key strategies include solar and wind power expansion,

green hydrogen production, and the deployment of hybrid energy systems. Projects like floating solar panels and offshore wind farms are diversifying energy sources.

To address power fluctuations, energy storage systems such as lithium-ion and flow batteries are being developed. Off-grid systems, like rooftop solar and microgrids, are improving electricity access in remote communities. The transition to sustainable transport is supported by schemes such as FAME-II and advancements in electric vehicle (EV) infrastructure.

Circular economy practices, including recycling of energy equipment and converting agricultural waste to biofuels, are being promoted to reduce carbon footprints. India is also playing a leadership role in global climate initiatives like the International Solar Alliance and the Lifestyle for Environment (LiFE) movement. Financial tools like green bonds are being leveraged to fund clean energy innovations. **Case Study 2: Gujarat's Charanka Solar Park**, spread across 5,384 acres, is one of Asia's largest solar parks with 600+ MW capacity. It has contributed to employment in local communities and has significantly reduced carbon emissions in the region (MNRE, 2023).

Table 2 India's Renewable Energy Capacity (2014–2023)

Year	Solar (GW)	Wind (GW)	Biomass (GW)	Total (GW)
2014	3.0	21.0	4.4	28.4
2017	12.0	32.0	8.0	52.0
2020	36.0	38.0	10.0	84.0
2023	70.0	42.0	13.0	170.0

(Source: MNRE, 2023)

Agriculture and Rural Innovation

Technology is transforming India's agricultural landscape. Precision farming tools, supported by satellite imagery and drones, have reached more than 5 million farmers (ICAR, 2023). Drone adoption has surged under the Sub-Mission on Agricultural Mechanization (SMAM). The *eNAM* platform facilitated ₹72,000 crore in agricultural trade in FY 2022–23, benefiting

1.7 crore farmers (MoA&FW, 2023). Karnataka's *Agristack* pilot has enabled real-time input delivery and reduced subsidy leakages by integrating 50 lakh farmer records (FAO, 2022).

Biotechnology and Healthtech India's biotech industry reached USD 92 billion in 2023 and is on track to exceed USD 150 billion by 2025 (IBEF, 2023). Key innovations include Covaxin and ZyCoV-D,

which vaccinated more than 250 million citizens during COVID-19, alongside the *Vaccine Maitri* program that provided over 100 million doses to developing countries (DBT, 2023). The *Ayushman Bharat Digital Mission (ABDM)* has registered over 430 million digital Health IDs, while the *eSanjeevani* teleconsultation platform has facilitated over 230 million virtual appointments (MoHFW, 2024). eSanjeevani Telemedicine Platform As of early 2023, the eSanjeevani platform had facilitated over 100 million consultations, providing access to medical care in remote and rural areas with limited infrastructure (MoHFW, 2023).

Space Technology and Strategic Innovation India's space sector has grown in both ambition and inclusivity. Between 2022 and 2024, ISRO launched 46 satellites and conducted missions such as *Chandrayaan-3* and *Aditya-L1* (ISRO, 2024). The private

sector, backed by IN-SPACe, raised over ₹1,000 crore in 2023 with firms like Skyroot and Agnikul preparing for commercial launches (Department of Space, 2024). Geospatial data use surged by 35% in 2023, improving disaster response and agricultural planning (ISRO Annual Report, 2024).

Industry 4.0 and Smart Manufacturing

The *SAMARTH Udyog Bharat 4.0* initiative has encouraged over 1,200 MSMEs to adopt smart technologies (Kumar & Srivastava, 2023). The *PLI* scheme contributed to a 20% growth in electronics exports and created over 250,000 jobs (DPIIT, 2023). India's mobile manufacturing exceeded 300 million units in 2023, up from 60 million in 2014. Under the ₹76,000 crore *India Semiconductor Mission*, the country's first fabrication plant is under construction in Gujarat (MeitY, 2023).

Table 3: Key Technologies Driving Industry 4.0 Adoption in India

Technology	Adoption Share (%)
Robotics	28%
IoT	35%
Additive Manufacturing	15%
AI/Data Analytics	22%

(Source: NASSCOM, 2022)

Sustainable Agriculture Technologies Agriculture remains vital to India's economy, employing a large portion of the population. Sustainable agriculture integrates modern technology with environmentally friendly practices. Precision farming tools, remote sensing, and AI-driven soil analytics are improving yield and resource use. Drone technology and automated irrigation are supporting real-time crop management.

Government schemes like PM-KISAN and PM-Fasal Bima Yojana offer financial assistance and crop insurance, and their integration with digital platforms ensures timely delivery. Programs promoting organic farming and agroforestry, such as the Paramparagat Krishi Vikas Yojana (PKVY) and the National Mission on Sustainable Agriculture (NMSA), support sustainable land use. Startups are playing a growing role

by offering mobile-based solutions, e-market access, and IoT-enabled farming tools.

Krishi Vigyan Kendras (KVKs) and Smart Farming KVKs have facilitated the deployment of smart irrigation systems, training over 1 million farmers in digital and sustainable practices. These centers bridge the gap between research institutions and field-level implementation (ICAR, 2023).

Other Critical Factors for Viksit Bharat

a) Education and Skilling for the Future

To ensure inclusive development; the education system must evolve to meet the demands of a technology-driven future. The National Education Policy (NEP) 2020 lays the foundation for a flexible, multidisciplinary education model. Emphasis on STEM (Science, Technology, Engineering, and Mathematics), coding, and digital literacy from early education stages is

crucial. Vocational training and skill development initiatives like Skill India, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), and digital skilling platforms are empowering youth to participate in new-age industries. Collaboration with industry for internships, apprenticeships, and real-world problem solving is essential to bridge the skill gap.

Skill India Mission and ITI Digitalization

The Skill India initiative has trained over 50 million youth since 2015. Integration of Industrial Training Institutes (ITIs) with digital platforms has increased placement rates and industry alignment (MSDE, 2023).

b) Urban Development and Smart Cities

Urban centers are central to India's development goals. The Smart Cities Mission is transforming over 100 cities into models of sustainable and tech-enabled urban living. Integrated command centers, IoT-based traffic management, and smart waste systems are improving urban infrastructure and governance.

Public-private partnerships (PPPs) are fostering innovation in affordable housing, mobility solutions, and energy-efficient infrastructure. Sustainable urbanization also emphasizes green spaces, water conservation, and reduced carbon emissions.

Table 4: Features Implemented in Smart Cities (2023)

Feature	Cities Implemented (%)
Smart Traffic Systems	78%
LED Street Lighting	65%
Surveillance and Safety	70%
Waste Management Automation	60%

(Source: MoHUA, 2023)

Inclusive Financial Systems and Digital Economy

Financial inclusion is fundamental for equitable development. Digital banking, UPI transactions, Jan Dhan accounts, and fintech startups have democratized access to financial services. Over 500 million Jan Dhan accounts have been opened, enabling low-income households to save and access credit.

Cryptocurrencies and blockchain are also emerging as disruptive technologies that could redefine digital transactions and secure record-keeping in governance, education, and healthcare.

Unified Payments Interface (UPI) India's UPI processed over 100 billion transactions in 2023, becoming the world's most widely used real-time payments system. It fosters micro-enterprise growth and supports cashless commerce (NPCI, 2023).

c) Water and Sanitation Management

Water security and sanitation are core to sustainable living. Initiatives like the Jal Jeevan Mission aim to provide piped water to every rural household. Technologies like

sensor-based water tracking, smart irrigation, and community water management platforms are improving efficiency and access.

The Swachh Bharat Mission has significantly improved sanitation coverage, with technology enabling real-time monitoring of waste disposal, toilet construction, and hygiene practices.

Jal Jeevan Mission Dashboard As of 2023, over 120 million rural households have access to tap water connections under the Jal Jeevan Mission. GIS and IoT technologies have enabled real-time monitoring of service delivery (Jal Shakti Ministry, 2023).

Challenges and the Way Forward Despite significant advancements, India faces the following challenges:

- **Digital Divide:** Over 350 million people remain unconnected, especially rural women and tribal communities (TRAI, 2023).
- **Cybersecurity:** India experienced over 12 million cyberattacks in 2023 (WEF, 2023).

- **Skilling Gap:** Over 50% of India's workforce needs reskilling by 2027 to match automation trends (WEF, 2023).
- **Environmental Sustainability:** Rapid tech growth must be balanced with ecological preservation (IEA, 2024).

To overcome these, India must raise R&D spending (currently 0.7% of GDP), establish regional innovation hubs, and foster public-private-academia partnerships for inclusive growth.

CONCLUSION

The road to *Viksit Bharat* is not only about adopting technology but embedding it in the social fabric through equity, education, and ecological responsibility. As India transitions into a knowledge economy, a strategic focus on innovation, sustainability, and inclusion will define its global leadership. The coming decades are a crucial window to shape India's technological destiny for the world.

Declaration by Author

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