

## Original Article

# Upcoming Trends in Technology and Sustainability: A Sociological Study of Technology

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### Abstract

Technology and sustainability are among the most powerful forces shaping the 21st century. However, the relationship between these two cannot be understood only through engineering, economics, or environmental science. Technology is deeply embedded in society, culture, politics, and everyday life; therefore, the sociology of technology becomes essential in understanding how sustainable technological trends emerge and how they influence social structures. This research paper explores "Upcoming Trends in Technology and Sustainability" through a sociological lens by analyzing how technological innovation interacts with social systems, inequalities, institutions, and cultural values. It highlights the argument that technology is not neutral but is socially constructed and influenced by power relations, market forces, and political ideologies.

The paper examines major sociological theories of technology—Technological Determinism, Social Construction of Technology (SCOT), Actor-Network Theory (ANT), and Risk Society—to interpret the shift toward sustainable technologies. It discusses emerging trends such as renewable energy, circular economy technologies, smart cities, sustainable manufacturing, artificial intelligence for climate governance, electric mobility, and green digital transformation. The paper also focuses on the social implications of these trends, including changes in labor markets, class-based access to green innovations, gendered technology adoption, digital divides, and environmental justice. Further, it investigates how institutions like governments, global organizations, and corporations shape sustainability agendas and influence public participation. Sociologically, the paper emphasizes that sustainable technological transitions require not only scientific innovations but also social transformation, inclusive governance, ethical frameworks, and cultural acceptance. The research concludes that achieving sustainability depends on aligning technological development with social equity, democratic decision-making, and environmental responsibility.

**Keywords:** sociology of technology, sustainability, green innovation, smart cities, circular economy

### Introduction

The modern world is increasingly defined by rapid technological advancements and growing environmental crises. On one side, technology offers solutions for development, health, communication, and industrial productivity. On the other side, modern technological systems have contributed significantly to environmental degradation, climate change, resource depletion, and social inequalities. Sustainability has emerged as an urgent global priority to ensure that present development does not compromise the capacity of future generations to meet their needs. However, sustainability is not purely an environmental concept; it is deeply linked to social justice, economic stability, governance, cultural behavior, and technological transformation.

In this context, the sociology of technology offers a meaningful approach to understand technology not as a neutral tool but as a socially embedded phenomenon. Technology does not develop in isolation. Instead, it emerges from social needs, political decisions, economic interests, institutional structures, and cultural beliefs. The diffusion of technology is also shaped by social acceptance, cultural compatibility, economic affordability, and accessibility. Thus, technological development and societal change operate together in a dynamic relationship.

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The theme “Upcoming Trends in Technology and Sustainability” reflects a new global era where technological innovation is increasingly being directed toward sustainable goals. Renewable energy technologies, green manufacturing, electric mobility, climate-monitoring systems, waste recycling, smart urban infrastructures, and artificial intelligence-based climate solutions are becoming central to the sustainability agenda. Yet, these trends bring new sociological concerns. For example, who controls these technologies? Who gains benefits from them? Who bears the risks? Do sustainable technologies

### **Sociology of Technology: Concept and Scope**

The sociology of technology studies how technology interacts with social structures and how society shapes technology. It challenges the common assumption that technology is simply an objective and neutral set of tools created by science. Instead, sociologists emphasize that technology reflects human values, cultural preferences, political interests, and economic power. This field explores technology as both a product and producer of social relations.

Technology influences:

- social organization and institutions
- economic systems and labor relations
- political governance and policy frameworks
- cultural identity and lifestyle patterns
- environmental conditions and ecological sustainability

The sociology of technology also focuses on inequalities related to access and control of technological resources. In many societies, privileged groups often have greater access to technological benefits, while marginalized groups are excluded. In sustainable technology, this inequality becomes even more critical because ecological solutions must be available to all for true sustainability.

### **Theoretical Perspectives in Sociology of Technology**

To understand sustainable technological trends sociologically, it is necessary to examine major theories in sociology of technology.

- **Technological Determinism**  
Technological determinism suggests that technology is the primary driver of social change. According to this view, society adapts to technological innovations. For example, the industrial revolution changed labor systems, urbanization patterns, and family structures. In modern times, digital technologies have transformed education, governance, and social communication.

reduce inequality or create new forms of injustice? Such questions cannot be addressed solely through science or policy; they require sociological interpretation.

The objective of this research paper is to analyze emerging sustainable technology trends through sociological theory and to examine their social consequences. The paper argues that sustainability transitions are not only technological shifts but also social transformations that require inclusive participation, ethical governance, and equity-based policies.

In sustainability, technological determinism often appears in the belief that technological innovation alone will solve environmental crises. For example, many assume that renewable energy or carbon capture will automatically fix climate change. However, sociology critiques this belief because it ignores the importance of social behavior, political action, and cultural change.

- **Social Construction of Technology (SCOT)**  
SCOT argues that technology is shaped by social groups and their interests. Different groups view technology differently and influence its development. For instance, renewable energy may represent environmental protection for activists, business opportunities for corporations, and national security for governments. Therefore, sustainable technologies are not neutral solutions but socially negotiated outcomes shaped by competing interests.
- **Actor-Network Theory (ANT)**  
ANT suggests that technology and society form networks that include both human actors (engineers, policymakers, citizens) and non-human actors (machines, resources, energy, infrastructure). Sustainable innovation depends on cooperation between these actors. For example, electric mobility requires battery technology, charging infrastructure, government subsidies, market demand, and social acceptance.
- **Risk Society**  
Ulrich Beck’s “Risk Society” theory states that modern development creates new risks such as pollution, nuclear hazards, global warming, and pandemics. Sustainable technologies are responses to the risks produced by industrial modernization. Sociology thus sees sustainability not as optional development but as a necessary transformation to control technological risks.

## Upcoming Trends in Technology and Sustainability

Sustainable development depends heavily on technological innovation. Several upcoming trends are influencing global sustainability transitions.

- **Renewable Energy Revolution**  
Renewable energy technologies such as solar power, wind energy, geothermal systems, and bioenergy are becoming dominant alternatives to fossil fuels. Solar panels are cheaper and more efficient than in previous decades. Wind farms are increasing, and smart grids are being developed to manage energy distribution.

**Sociological implications:** Renewable energy changes power relations in society. Fossil fuel industries lose dominance while new green industries gain influence. Renewable technologies can empower rural communities through decentralized energy systems. However, renewable systems also create inequality if only wealthy communities can afford solar rooftops while poor communities remain dependent on expensive energy sources.

- **Electric Mobility and Sustainable Transport**  
Electric vehicles (EVs), hydrogen mobility, and public transport innovations are expanding as alternatives to petrol and diesel vehicles. Many countries are creating policy incentives for EV adoption.

**Sociological implications:** EVs influence class identity and lifestyle. In developing countries, electric cars may remain luxury products, creating green inequality. Sustainable transport also demands cultural change, as people must shift from private car dependence to public mobility systems. Adoption depends on social norms, affordability, and infrastructure.

### 4.3 Smart Cities and Sustainable Urban Systems

Smart city programs integrate technologies such as IoT sensors, AI-based monitoring, smart traffic management, waste tracking systems, and green infrastructure.

#### **Sociological implications:**

Smart cities can improve sustainability but may increase social exclusion. Data-driven governance risks surveillance, privacy violation, and corporate control. Additionally, smart cities often benefit elite zones, while slums and informal settlements remain ignored.

- **Circular Economy and Advanced Recycling Technologies**

Circular economy focuses on reducing waste through recycling, repairing, and reusing materials. Technologies like waste-to-energy plants, plastic recycling innovations, and e-waste management tools are increasing.

#### **Sociological implications:**

Waste management is socially linked to informal labor. In countries like India, informal waste pickers play key roles. If advanced waste systems ignore informal workers, social exclusion may occur. Sustainable recycling must include social justice.

- **Artificial Intelligence for Environmental Governance**

AI is emerging as a major tool in sustainability. AI supports climate modeling, disaster prediction, biodiversity mapping, energy optimization, and carbon footprint calculation.

#### **Sociological implications:**

AI-driven sustainability raises ethical issues related to data inequality and algorithmic bias. If AI systems are controlled by global corporations, sustainability governance may become centralized and undemocratic. Additionally, AI may replace certain jobs, impacting labor markets.

- **Sustainable Manufacturing and Green Engineering**

Industries are adopting greener production methods such as cleaner energy use, eco-design, biodegradable materials, and sustainable packaging.

#### **Sociological implications:**

Green manufacturing reshapes labor demands. Traditional workers may lose employment due to automation and green restructuring. New skills are required, making training programs essential. Sociology emphasizes “just transition,” ensuring that workers are not socially harmed during sustainability shifts.

### **Social Impacts of Sustainable Technology Trends**

Sustainable technological innovation influences society in multiple ways.

#### 1. Social Inequality and Technological Access

A major issue is unequal access to sustainable technology. Poor communities often lack financial resources, digital literacy, and infrastructure. As a result, green technology becomes a privilege.

For example, solar systems are affordable for middle-class households but not for rural poor. Similarly, EV adoption is limited due to high cost. Sustainability transitions must address equity to prevent green inequality.

#### 2. Transformation of Work and Labor

Sustainability technologies create new employment sectors such as renewable energy, recycling industries, and green construction. However, they also reduce jobs in fossil fuel industries and traditional manufacturing.

This creates the need for policies focused on:

- reskilling programs
- social security
- fair wages
- inclusive employment

### 3. Cultural Behavior and Lifestyle Change

Technology cannot ensure sustainability without cultural changes. Sustainable living requires changes in consumption habits, transportation patterns, energy use, and waste management.

For example:

- adopting public transport
- reducing plastic consumption
- switching to renewable energy
- accepting eco-friendly products

Sociology explains that people resist change when it threatens their identity or lifestyle norms. Therefore, awareness and cultural adaptation are essential.

### 4. Gender and Technology in Sustainability

Gender inequality shapes technological adoption. In many societies, women face barriers in education and digital access. Women may not participate equally in green innovation projects.

Sustainable technologies must include gender-sensitive policies such as:

digital literacy programs for women

- inclusive participation in decision-making
- women-led sustainability enterprises

### Environmental Justice and Sustainable Technology

Environmental justice emphasizes that environmental benefits and burdens must be shared equally across society. Technological sustainability must ensure justice.

For example:

- waste disposal plants are often located near poor communities
- industrial pollution affects marginalized groups more
- climate disasters hit weaker sections hardest

Sociology argues that sustainable technologies must not reproduce inequality. Policies should prioritize vulnerable communities, ensuring fair distribution of resources.

### Governance, Policy, and Corporate Influence

Governments and global institutions play significant roles in sustainability transitions. Policies like subsidies, regulations, carbon pricing, and environmental laws influence technology adoption.

However, corporations often dominate sustainability agendas. This creates the concept of "green capitalism," where sustainability becomes a marketing strategy rather than real transformation.

Sociological critique suggests:

- need for democratic governance
- public participation in sustainability planning
- transparency in corporate sustainability claims

### Future Directions: Technology, Society, and Sustainability

The future of sustainability is not only technological but also social. Upcoming trends indicate that technology will continue shaping environmental strategies.

Key future focus areas include:

- citizen-centered smart sustainability
- community renewable energy systems
- inclusive green education
- ethical AI governance
- sustainable innovation through social participation

Sociology highlights that sustainability must involve people, not only technology.

### Conclusion

This research paper has examined upcoming trends in technology and sustainability through the sociology of technology. It argues that sustainability transitions are not purely technological solutions but social transformations. The sociology of technology demonstrates that technology is socially constructed and reflects power relations, cultural values, and inequalities.

Emerging trends such as renewable energy, electric mobility, smart cities, circular economy technologies, AI-based climate tools, and green manufacturing show strong potential to support sustainability. Yet, these trends create challenges such as social inequality, digital divides, labor displacement, gender barriers, surveillance risks, corporate dominance, and environmental injustice.

To ensure a sustainable future, technological innovation must be combined with social equity, inclusive governance, ethical regulation, and cultural transformation. Sustainability can succeed only when society as a whole participates, benefits, and shares responsibility. Thus, sociology of technology is crucial in shaping a future where technology supports both environmental protection and social development.

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