



REPORT ON DIGITIZATION, GREEN & CLEAN SECTORS IN INDIA

Covering Policy Initiatives, Standardization, Growth Drivers, and Challenges



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Contents

1. Executive Summary	3
2. Digitization	7
3.1 5G/6G	8
i. Key policy initiatives	9
ii. Growth Drivers	10
iii. Challenges	10
iv. Standardization 5G/6G	11
3.2 Artificial Intelligence (AI)	11
i. Key policy initiatives	12
ii. Growth Drivers	14
iii. Challenges	15
iv. Standardization: AI	16
3.3 IoT/M2M	17
i. Key policy initiatives	17
ii. Growth Drivers	19
iii. Challenges	19
iv. Standardization	19
3.4 Quantum Technologies and High-Performance Computing (HPC)	20
i. Key policy initiatives	20
ii. Growth Drivers	22
iii. Challenges	23
iv. Standardization: Quantum technology	23
3.5 Blockchain	24
i. Key policy initiatives	24
ii. Growth Drivers	25
iii. Challenges	26
iv. Standardization: Blockchain	26
3.6 Cybersecurity/Data privacy	26
i. Key policy initiatives	27
ii. Growth drivers	29
iii. Challenges	30
iv. Standardization	31

3.7	Electronic/Digital signature	31
i.	Key Policy Initiatives	31
ii.	Growth Drivers	32
iii.	Challenges	32
iv.	Standardization	32
3.8	E-accessibility	33
i.	Key policy initiatives	33
ii.	Standardization	35
3.9	Smart Cities/Urban Development	35
i.	Key policy initiatives	35
ii.	Growth Drivers	38
iii.	Challenges	38
iv.	Standardization	39
3.10	Smart Grid/Meter	41
i.	Key policy initiatives	41
ii.	Growth Drivers	42
iii.	Challenges	42
iv.	Standardization	43
3.	Green and Clean Technologies	44
3.1.	Green Hydrogen	45
i.	Key policy initiative	46
ii.	Growth drivers	49
iii.	Challenges	49
iv.	Standardization	50
3.2.	Circular Economy/Resource Efficiency	50
i.	Key policy initiatives	52
ii.	Growth Drivers	54
iii.	Challenges	54
iv.	Standardization	55
3.3.	Electric Vehicle	56
i.	Key policy initiatives	57
ii.	Growth Drivers	59
iii.	Challenges	59

iv.	Standardization	60
3.4.	Energy Storage Systems (ESS)	62
i.	Key policy initiatives	62
ii.	Growth Drivers	64
iii.	Challenges	64
iv.	Standardization	65
4.	Glossary	65
5.	Sources	67

1. Executive Summary

The International Monetary Fund (IMF) has lauded India's stellar economic performance, projecting the nation to contribute more than 16 per cent to global growth, thanks to the robust growth fuelled by key reforms in digitisation and infrastructure. The IMF's annual Article IV consultation with India, affirms the country's trajectory as one of the fastest-growing major economies globally. Despite facing global headwinds, including a slowdown in a fragmented world, India's prudent macroeconomic policies continue to drive its economic momentum.

The stupendous growth in the economy is attributed to the government vision of creating and establishing INDIA as a digital economy or a digitally driven economy. Deep penetration of telecom and internet, combined with government's focus to develop digital public infrastructure, have laid the foundation for a digital economy.

However, along with the rapid emergence of new technologies, the impact of climate change is increasingly felt. The need for sustainable development is progressively realized by the Indian Government, which is more discerning now on the issues related to safety, performance, reliability, security, and sustainability. And hence, the green and digital transition are increasingly becoming the most important twin priorities for India.

Digitization and Emergence of New Technologies

'Digital India' initiative launched in 2015 by GoI aims to improve online infrastructure and increase internet accessibility for citizens, empowering them to become more digitally advanced. This initiative encompasses three key dimensions namely, a) establishing a secure digital infrastructure, b) delivering digital services and c) ensuring that every citizen has access to the Internet.

GoI's persistent effort to digitalize the Indian economy and make India's population at large participate in it, is already showing results. It has considerably reduced the

distance between government and citizens by enabling the delivery of substantial services directly to the beneficiary in a transparent and corruption-free manner. In fact, India has emerged as one of the pre-eminent nations of the world to use technology to transform the lives of its citizens.

Further, the digitalization drive has also led to a faster formalization of the economy. For example, Smart Cities mission will have ICT / Digitization as the common conduit for all smart services and IoT/M2M is playing a key role. Similarly, Smart Grid Mission, E-Accessibility, Digital Signatures, etc. are some of the key initiatives undertaken. These initiatives and missions are aligned with the vision of the Government of India's National Digital Communication Policy, 2018 which aims to build Robust Digital Communications Infrastructure, harness the power of emerging digital technologies, including 5G, AI, IoT, Cloud and Big Data to enable provision of future ready products and services, while recognizing data as a crucial resource, ensuring Sovereignty, Safety and Security of Digital Communications

India is also prepping for cutting-edge technologies including 5G/6G, AI, blockchain, augmented reality, virtual reality, machine learning, deep learning, robots, etc. These will be critical in the government and industry, for planning or decision-making, expediting development or analysing deployment, solving issues or product creation, detecting new trends or drawing out linkages and associations.

The Government of India has also envisioned to support research and development and adoption of such technologies. India has just introduced 5G, which at its peak can deliver internet speeds of up to 10 gigabits per second; at the same time, a comprehensive vision document on the futuristic 6G broadband was unveiled by the Indian Prime Minister. TIG-6G - the Technology Innovation Group on 6G, has developed the Bharat 6G Vision, a strategy to create 6G technology in India by 2030. The objective of this vision is to create and deploy 6G network technologies that provide secure, intelligent, and pervasive connectivity, enabling people all over the world to live better lives.

In view of the possible impact of AI on the economy and society Government of India has taken several steps to drive the adoption of Artificial Intelligence (AI) which include creation of inter-ministerial Task Force on Artificial Intelligence (AI) , discussion paper on National Strategy for Artificial Intelligence (AI) which aims to guide research and development in new and emerging technologies.

M2M communication is going to play a major role and will contribute significantly towards the government initiatives 'Digital India' and 'Make in India'. The emerging automation trend in industrial processes, the increasing sales of connected cars, and the widespread adoption of IoT-enabled devices in the healthcare industry represent some of the key factors driving the market. The government of India has adopted international standards set by OneM2M alliance and Release 2 and Release 3 standards were adopted as national standards through TEC, the technical wing of DoT.

India is also taking leaps in the Quantum Technologies which is being touted as the most advanced technology. With the announcement of National Quantum Mission, India is on the global quantum map and has nearly a hundred quantum projects at present, about 92% of which are sponsored by the Centre. The Telecom Engineering Centre (TEC has released two standards in the field of quantum technologies, which are [TEC 91010:2023 - Generic Requirements for Post Quantum Cryptography](#) and [TEC 91000:2022 - Quantum Key Distribution \(QKD\) systems](#).

Rapid digitization in the past few years has resulted in the growth of technology at a pace that is difficult for policymakers and society to grasp. Digitization enhances social benefits but introduces cybersecurity risks and challenges, especially from emerging technologies, necessitating robust, globally interoperable cybersecurity policies. In response to digital transformation, emerging technologies and connected cybersecurity risks, many governments have started imposing cybersecurity requirements, especially when national security, economic security or public health and safety is at stake. Government of India has also announced the [Digital Personal Data Protection \(DPDP\) Act](#) which was notified in the Official Gazette on 11 August 2023. The act borrows its broad definition of personal data from the EU's General Data Protection Regulation (GDPR) and aims to protect data principals and restrict the activities of data fiduciaries.

Clean and Green Technologies

India's announcement that it aims to reach net zero emissions by 2070 and to meet fifty percent of its electricity requirements from renewable energy sources by 2030 is a hugely significant moment for the global fight against climate change. India is pioneering a new model of economic development that could avoid the carbon-intensive approaches that many countries have pursued in the past – and provide a blueprint for other developing economies.

Due to the rapid growth in fossil energy consumption, India's annual CO₂ emissions have risen to become the third highest in the world. India's sheer size and its huge scope for growth means that its energy demand is set to grow by more than that of any other country in the coming decades. The clean energy transition in India is already well underway. It has overachieved its commitment made at COP 21- Paris Summit by already meeting 40% of its power capacity from non-fossil fuels- almost nine years ahead of its commitment and the share of solar and wind in India's energy mix have grown phenomenally. The remarkable growth of solar and wind energy capacity has cemented India's position as a global leader in renewable energy adoption. Today, India stands 4th globally in Renewable Energy Installed Capacity, with 43% of its total installed electricity capacity coming from non-fossil energy sources.

India already has a numerous policy measure in place that – if fully implemented – could address some of these challenges by accelerating the shift to cleaner and more efficient technologies. India is also laying the groundwork to scale up important emerging technologies such as hydrogen, battery storage, low-carbon steel, cement, and fertilisers. A transition to clean energy is a huge economic opportunity and India is particularly well placed to become a global leader in renewable batteries and green hydrogen.

India's energy transition needs to benefit its citizens, and well-designed policies can limit the potential trade-offs between affordability, security, and sustainability. Green hydrogen will play a major role in achieving the net zero and decarbonising the hard-to-abate sectors. India aims to become a global hub for green hydrogen production and exports. In this direction, India has established several policies and guidelines to promote green hydrogen to aid in the smooth implementation of the [National Hydrogen Mission](#). For further progress the National Green Hydrogen Mission, in August 2023, the Ministry of New and Renewable Energy (MNRE) has notified the [Green Hydrogen](#)

[Standard for India](#), outlining the emission thresholds for production of hydrogen that can be classified as 'green'.

The need for India to adopt a circular economy model to reverse the environmental crisis has become increasingly pressing, given the country's rapidly expanding population, swift urbanisation, and escalating environmental pollution and climate change. A dedicated Circular Economy Cell (CE Cell) has been constituted in NITI Aayog in September 2022 to work in the areas of Circular Economy.

The Government has been actively formulating policies and promoting projects to drive the country towards a Circular economy/Resource efficiency. It has already notified various rules, such as the [Plastic Waste Management Rules](#), [e-Waste Management Rules](#), [Construction and Demolition Waste Management Rules](#), [Battery Waste Management Rules 2022](#), [Solid Waste Management Rules, 2016](#), [Metals Recycling Policy](#) etc., in this regard. The Rules are geared towards reducing waste generation and maximizing recycling of waste.

In November, 2017, NITI Aayog along with EU Delegation to India prepared a [Strategy paper on Resource Efficiency](#) and following up on this strategy paper, in January 2019, a status paper titled "[Resource Efficiency & Circular Economy – Current status and Way forward](#)" has also been released with four focus areas namely steel, aluminium, E-waste and Construction & Demolition waste.

To take ahead the 'LiFE' - 'Lifestyle for Environment' mission movement as announced by the Hon'ble Prime Minister in 2021, the Ministry of Environment, Forest and Climate Change has introduced two pioneering initiatives that indicate the country's pro-active approach to climate change, sustainability, and promotion of eco-conscious practices. These initiatives are [Green Credit Program \(GCP\)](#) and the [Ecomark Scheme](#), which seek to encourage environmentally friendly practices rooted in tradition and conservation; reflecting the ideas of LiFE concept.

This report consolidated by the SESEI Project, provides overview of the policy initiatives, standardization, growth factors and challenges associated with the:

- digital and emerging technologies, ranging from the 5G / 6G, internet of things (IoT), artificial intelligence (AI) and quantum computing, etc.
- Various digitally driven projects / missions initiated by the Government of India, focused on adoption of new and emerging technologies.
- Policy and Standardization initiatives in the realm of Circular Economy and Resource efficiency etc.

The main objective of this report is to provide all necessary information and update on the important policy and standardization efforts undertaken by the Indian government and the future projections and possibilities from the viewpoint of investments, trade & standardisation.

2. Digitization

The Indian government has launched several digital initiatives to improve access to services and promote digital literacy. The [Digital India program](#) aims to provide broadband connectivity to all villages in the country, promote e-governance, and encourage the use of digital payments. The government has also launched several initiatives to promote the digitization in the country.

a) **Digital India**

Digital India is a campaign launched by the Government of India on 1 July 2015 to ensure that Government services are made available to citizens electronically by improved online infrastructure and by increasing Internet connectivity or by making the country digitally empowered in the field of technology. The Ministry of Communications and IT is the nodal agency to implement the program.

The initiative includes plans to connect rural areas with high-speed internet networks. Digital India consists of three core components i.e., Development of secure and stable Digital Infrastructure, Delivering government services digitally and Universal Digital Literacy. For more information, please click [here](#)

b) **National Digital Communications Policy 2018**

In September 2018, Government of India released the National Digital Communications Policy-2018 (NDCP2018) to achieve the goal of digital empowerment and well-being of the people of India; and towards this end, attempts to outline a set of goals, initiatives, strategies and intended policy outcomes.

Vision:

To fulfil the information and communication needs of citizens and enterprises through the establishment of a ubiquitous, resilient, secure, accessible, and affordable Digital Communications Infrastructure and Services, and in the process, support India's transition to a digitally empowered economy and society.

Mission:

In pursuit of accomplishing these objectives by year 2022, the National Digital Communications Policy, 2018 envisages three Missions:

1. **Connect India:** Creating Robust Digital Communications Infrastructure

To promote Broadband for All as a tool for socio-economic development, while ensuring service quality and environmental sustainability.

2. **Propel India:** Enabling Next Generation Technologies and Services through Investments, Innovation and IPR generation.

To harness the power of emerging digital technologies, including 5G, AI, IoT, Cloud and Big Data to enable provision of future ready products and services; and to catalyse the fourth industrial revolution (Industry 4.0) by promoting Investments, Innovation and IPR.

3. **Secure India:** Ensuring Sovereignty, Safety and Security of Digital Communications

To secure the interests of citizens and safeguard the digital sovereignty of India with a focus on ensuring individual autonomy and choice, data ownership, privacy, and security, while recognizing data as a crucial economic resource.

For more information, please [click here>>](#)

3.1 5G/6G

The conversation about 5G networks in India started in 2017 when the government of India constituted a [High-Level Forum on 5G India 2020](#) to articulate the Vision for 5G in India and to recommend policy initiatives and action plans to realize this vision. In August 2018, the High-Level Forum released a report titled as "[Making India 5G ready](#)" suggesting measures in the area of Spectrum Policy, Regulatory Policy, Education and Awareness Promotion Program, Application & Use Case Labs, Development of Application Layer Standards, Major Trials and Technology Demonstration and Participation in International Standards.

The Telecom Regulatory Authority of India (TRAI) also released a White Paper on '[Enabling 5G in India](#)' on 22nd February 2019. This White Paper highlights the specifications of the 5G technology, discusses the potential use cases and architecture of 5G network, deliberates those areas that will require investment for 5G deployment, covers the spectrum requirements for 5G networks, and tries to identify regulatory challenges that need to be addressed for the deployment of 5G in India.

In July-August 2022, the Department of Telecommunications (DoT) allocated spectrum to telecom operators, paving the way for launch of 5G services. The telcos spent over INR 1.5 lakh cr. (~€17 Bn) in acquiring the 5G spectrum.

5G services were formally launched by Government of India in October 2022. 5G has been a success in India in terms of rollout. The country has witnessed one of the fastest 5G roll out and has become the second largest 5G network in the world. As of August 2023, Telecom Services providers Reliance Jio and Bharti Airtel have installed over 3 lakh sites in 714 districts.

According to Ericsson Mobility Report 2023, India is expected to have 700 million 5G subscribers by the end of calendar 2028, comprising 57% of its 1.2 billion mobile phone users, making it the fastest growing 5G market globally. With 5G user base set to expand, 4G subscriptions are forecasted to drop from 820 million in 2022 to 500 million by 2028¹.

As 5G technology gains inroads, India has also started taking necessary steps to move beyond the deployment of 5G technology. India is planning to launch [6G](#) services by 2030 and has set an eye of being a global leader with the network technology.

¹ <https://www.livemint.com/industry/telecom/india-to-have-700-mn-5g-subscribers-by-2028-end-ericsson-11687360971980.html>

i. Key policy initiatives

Government has taken following significant steps to accelerate the R&D of 6G technology:

a) 6G Technology Innovation Group (TIG)

In Nov. 2021, DoT formed a 6G Technology Innovation Group (TIG) with an aim to give a boost to the development activities of 6G technology at the national and global levels.

- To frame a roadmap for R&D activities, pre-standardization, development of applications on 6G technology.
- To identify the area of work and build synergy to innovate, create IPR, standardize, contribute to global standards, create regulations, run pilots, and manufacture, test, and supply at a global scale.

Under **6G TIG**, Telecom Department (DoT) formed **6 task forces** making industry representation symbolic.

- task forces are headed by various academia from across the country Directors of IIT-Madras, IIT-Kanpur, IISc among others.
- deliverables include Mapping of global 6G activities; India's competencies and potential pre-Standardization activities; Mission 6G program; Research views on IMT for 2030 and beyond; about Networks, Devices, Spectrum, multi-disciplinary innovative solutions.

Based on the reports of the Six Task Forces, in March 2023, Government of India unveiled a "[Bharat 6G Vision](#)" document prepared by the Technology Innovation Group on 6G. The objective of this vision document is to create and deploy 6G network technologies that provide secure, intelligent, and pervasive connectivity, enabling people all over the world to live better lives. The Vision statement emphasises India's commitment to socioeconomic prosperity, as well as the potential benefits of India's pioneering 6G technology.

As per the document, the government is planning to implement 6G in two phases, the first one from 2023 to 2025 and the second one from 2025 to 2030. The government has also appointed an apex council to oversee the project and focus on issues such as standardisation, identification of the spectrum for 6G usage, create an ecosystem for devices and systems, and figure out finances for research and development, among other things.

b) 6G R&D Test Bed

In a big boost to India's innovation ecosystem, Government of India has launched the indigenous research and development (R&D) test bed for 6G on 22 March 2023. The 6G Test Bed will provide a platform for academic institutions, industry, start-ups, MSMEs, and industry, among others, to test and verify evolving ICT technologies.

c) Bharat 6G Alliance - B6GA

In July 2023, the Department of Telecommunications (DoT) under the Ministry of Communications launched the Bharat 6G Alliance (B6GA) to foster innovation and leadership in 6G technology.

The Bharat 6G Alliance, an alliance of domestic industry, academia, national research institutions and standards organisations facilitated by the Government, is expected to chart its own course of action based on the Bharat 6G Vision Document and further developments.

B6GA will focus on the following:

1. To help grow 5G Advanced/6G IPs and essential patents from India.
2. Design and build Indian 5G Advanced/6G products and solutions;
3. Support and energise Indian participation in 3GPP/ITU;
4. To help build consortia of Indian Startups and companies;
5. To facilitate market access for Indian 5G/6G technology products;
6. Build coalition with like-minded 6G Global Alliances.

For more information, please [click here>>](#)

ii. Growth Drivers

- **Growing adoption of emerging technologies:** 5G enables businesses to implement advanced technologies like IoT/M2M, augmented reality (AR), virtual reality (VR), Artificial Intelligence (AI) and edge computing, leading to enhanced customer experiences and operational efficiency.
- **Increasing demand for Data:** The increasing demand for high-speed data services, video streaming, and IoT applications is driving the need for higher bandwidth and faster network speeds that 5G can offer.
- **IoT and Industry 4.0:** 5G's low latency and high connectivity capacity are essential for powering IoT devices and applications in sectors like manufacturing, agriculture, healthcare, and smart cities.
- **Government support** - The government launched programs like BharatNet and has been developing other policies on infrastructure sharing and street furniture usage, which will enable smoother network service from telecoms.
- **Innovation and Startups:** 5G's capabilities are expected to drive innovation across sectors, giving rise to new services, applications, and business models, which can benefit startups and technology ecosystems.

iii. Challenges

- **Infrastructure:** Deploying 5G infrastructure requires significant investments in new cell towers, fiber optic networks, and other equipment. The existing infrastructure might need substantial upgrades.

- **High Costs:** Building 5G networks involves substantial costs, including spectrum acquisition, infrastructure deployment, and technology upgrades. Balancing these costs with potential revenues can be complex.
- **Device Compatibility:** Not all devices are 5G-compatible, which can lead to a lag between network deployment and device availability. Many users will require to change their devices and it will result in a financial burden on some users and thus will contribute to challenges in its rollout.

iv. Standardization 5G/6G

From the 5G standardization perspective, India has developed its own local 5G standard called "5Gi". 5Gi is jointly developed by IIT Madras, IIT Hyderabad, TSDSI, and the Centre of Excellence in Wireless Technology (CEWiT). The homegrown 5Gi standard (also known as Radio Interface Technology or RIT) is aimed at improving 5G coverage in rural and remote areas of India's diverse geographical terrain.

The 5Gi standard uses Low Mobility Large Cell (LMLC) to extend 5G connectivity and the range of a base station. It does so by using bands of the spectrum, which are lower than 5G's operational bands but offer a high-range waveform. Ideally, the 5G frequency band ranges from 700MHz to 52GHz, but 5Gi can go lower than 700MHz and up to 36GHz without sacrificing the range. Apart from that, the LMLC technology increases the intersite distance to 6 km from 5G's 1.7 km, which should make the deployment cost-effective.

In December 2021, the ITU (International Telecommunication Union) approved the 5Gi standard and it has now been formally merged with the 3GPP 5G Standard and implemented into the 3GPP Rel-17 NR specifications.

TSDSI has been transposing the 3GPP specifications and making them available to TEC for adoption as the Indian national standards in a timely manner. Please [click here](#) for the list of standards that have been created by transposition of relevant 3GPP technical specifications. The list consists of standards required to meet ITU-R / national requirements.

Telecommunication Engineering Centre (TEC) has also spearheaded India's standardization work on ITU 6G Framework. The National Study Group (NSG), headed by TEC, has done extensive work in submitting regular Indian contributions towards the development of the ITU 6G framework. The inclusive approach adopted by TEC has resulted in wide stakeholder participation in the National Study Group with involvement of major industries, startups, academia, and R&D organizations.

The TEC led NSG has been working on this framework since last few years and has been advocating for India specific requirements at the international forum.

3.2 Artificial Intelligence (AI)

Indian government is relentlessly working towards building a robust growth ecosystem to ensure healthy development of AI in India and its applications in various components of governance and social development. According to a report by International Data Corporation (IDC), India's AI market is anticipated to reach USD 7.8 billion by 2025 at a Compound Annual Growth Rate (CAGR) of 20.2% from a market value of USD 3.1 billion in 2020. Moreover, the AI services market is set to lead the overall AI market growth in India by 2025 at a CAGR of 35.8%. IDC also predicts that the India AI software market will grow from USD 2,767.5 million in 2020 to USD 6,358.8 million in 2025, at a CAGR of 18.1%².

Currently, India does not have any specific law regarding application of AI. The Ministry of Electronics and Information Technology (MeiTY) is the regulatory body of AI in India. It has the responsibility development, implementation and management of AI laws and guidelines in India. There are certain provisions mentioned under Intellectual Property Law and several provisions as Section 43A & 72A of Information Technology Act, 2000 which implies that if anyone commits crime by using AI, then he/she will be liable under IT Act, criminal law, and other cyber law. Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules 2021 obligates the social media platforms to exercise greater diligence regarding content on their platforms.

India recently assumed the Chair of the Global Partnership on Artificial Intelligence (GPAI) for 2022-23. GPAI (<https://gpai.ai/>) is an international initiative to support responsible and human-centric development and use of Artificial Intelligence (AI).

During the recent successful G20 Summit, India proposed a "Framework for Responsible Human-Centric AI governance" which aims to ensure that AI serves the global community while safeguarding against misuse.

i. Key policy initiatives

Government of India has taken several steps to drive the adoption of Artificial Intelligence (AI) which include the following: -

a) Task Force on Artificial Intelligence (AI)

On 24th August 2017, Ministry of Commerce and Industry had constituted a [Task Force on Artificial Intelligence \(AI\)](#) for India's Economic Transformation. The Task Force gave its [report](#) on 19th January 2018. It has recommended an Inter-Ministerial National Artificial Intelligence Mission to act as a nodal agency for coordinating AI related activities in India. The recommendations of the Task Force have been shared with various Ministries and Departments of the Government of India.

b) National Strategy for Artificial Intelligence (AI) 2018

In June 2018, the government think-tank, National Institution for Transforming India (NITI) Aayog has released a discussion paper on National Strategy for Artificial Intelligence (AI) which aims to guide research and development in new and emerging technologies.

² <https://indiaai.gov.in/article/india-s-ai-market-to-reach-usd-7-8-billion-by-2025-says-idc-s-latest-report-on-ai>

- This strategy document is premised on the proposition that India, given its strengths and characteristics, has the potential to position itself among leaders on the global AI map.
- NITI Aayog has identified five sectors — **healthcare, agriculture, education, smart cities and infrastructure and transportation** — to focus its efforts on implementation of AI.
- The paper focuses on how India can leverage the transformative technologies to ensure social and inclusive growth.

For more information please [click here/Download>>](#)

As a follow up to National Strategy for AI, NITI Aayog has published following discussion papers on Responsible Artificial Intelligence (RAI):

- NITI Aayog's paper titled "**Responsible AI for All: Approach Document for India: Part 1 – Principles for Responsible AI**" was the 1st in the series of its publication on RAI. The paper incorporates insights, feedback and experiences consolidated through inter - ministerial consultations, large-scale global multi-stakeholder consultations and a series of 1-1 consultations with AI ethics experts in India and globally, as well as wider public consultations. This paper is meant to serve as an essential roadmap for the AI ecosystem, encouraging adoption of AI in a responsible manner in India and building public trust in the use of this technology, placing the idea of 'AI for All' at its very core. [Download>>](#)
- NITI Aayog's 2nd paper titled "**Responsible AI for All: Approach Document for India: Part 2 - Operationalizing Principles for Responsible AI**". This paper identifies a series of actions that the ecosystem must adopt to drive responsible AI. These actions are divided among three stakeholders: governments, the private sector and research institutions. Among these stakeholders, the actions are further divided into areas, with each area identifying a series of related measures for implementing the AI principle. [Download>>](#)
- NITI Aayog brings the third paper titled "**Responsible AI for All: Adopting the Framework – A use case approach on Facial Recognition Technology**". This Paper establishes a framework for responsible and safe development and deployment of facial recognition technology (FRT) within India. [Download paper>>](#)

c) National AI portal

The Indian Government launched National Artificial Intelligence Portal (www.ai.gov.in) on 30 May 2020. The portal works as a one-stop digital platform for AI related developments in India, sharing of resources such as articles, start-ups, investment funds in AI, resources, companies, and educational institutions related to AI in India. The portal also shares documents, case studies, research reports etc. It also has a section about learning and new job roles related to AI. The government has also launched a national programme for youth named 'Responsible AI for Youth'. It aims at empowering the young students of the country with an appropriate new-age tech mindset, access to required AI toolset and relevant AI skill sets to make the youth digitally ready for the future. For more information please [click here>>](#)

d) Committees reports on AI: MEITY

To create a policy framework and to develop the ecosystem for Artificial Intelligence, Meity has constituted four committees covering all the aspects of AI. Meity has released following Committees reports on AI:

- Report of committee - A on platforms and data on AI [Read more/Download](#)
- Report of committee - B on leveraging AI for identifying national missions in key sectors [Read more/Download](#)
- Report of committee - C on mapping technological capabilities, key policy enablers required across sectors, skilling, reskill [Read more/Download](#)
- Report of committee - D on cyber security, safety, legal and ethical issues [Read more/Download](#)

e) National Program on Artificial Intelligence

India AI program is envisioned as an umbrella programme by the Ministry of Electronics and Information Technology (MeitY) for leveraging transformative technologies to foster inclusion, innovation, and adoption for social impact. Pillars of India AI include Data for AI, Skilling, AI Ethics and Governance, Compute, AI Research and Development, National Center for AI, among others. To actualize this vision of India AI, MeitY has undertaken the implementation of the "National Program on Artificial Intelligence" with the objective of establishing a comprehensive programme for leveraging transformative technologies to foster inclusion, innovation, and adoption for social impact. It encompasses four broad pillars of the AI ecosystem, including Skilling in AI, Responsible AI, Data Management Office, and the National Centre on AI.

ii. Growth Drivers

Major growth drivers for the India artificial intelligence (AI) market include:

- **Data availability for AI model training:** The growing digital landscape in India generates vast amounts of data. Access to diverse datasets is crucial for training AI models, and India's data abundance can contribute to AI advancements.
- **Increasing professionals in AI:** Over the past few years, India has seen a significant growth of professionals skilled in AI. According to LinkedIn's report, People skilled in artificial intelligence (AI) in India went up by 14x in June 2023 compared to January 2016, putting India in the top five countries for AI talent increase, alongside Singapore, Finland, Ireland, and Canada³.
- **Increasing number of AI Startup:** India has seen a surge in AI startups working on diverse applications, from healthcare to agriculture. These startups receive support from investors, accelerators, and incubators, fuelling innovation. According to Stanford University's annual AI Index report, India ranked fifth in terms of investments received by startups offering artificial intelligence (AI)-based products and services in 2022. Total investments in AI startups in India stood at \$3.24 billion

³ <https://economictimes.indiatimes.com/jobs/fresher/seven-in-10-indian-gen-z-professionals-believe-ai-skills-will-help-them-progress-in-their-careers-survey/articleshow/103007191.cms?from=mdr>

in 2022, placing it ahead of South Korea, Germany, Canada, and Australia, among others⁴.

- **Favourable Government policies:** The Indian government has also recognized the potential of AI and has launched several initiatives such as National AI Strategy to promote its adoption⁵.

iii. Challenges

- **Data quality:** While data availability is an advantage, **Data** quality is **crucial** in AI because it directly impacts the performance, accuracy, and reliability of **AI** models. High-quality data enables models to make better predictions and produce more reliable outcomes, fostering trust and confidence among users.
- **Data security and privacy:** AI systems rely on large amounts of confidential data, which are often sensitive and personal in nature. Along with automation, AI also brings a range of security and privacy vulnerabilities, which can subsequently exacerbate any organisation's exposure to cyber risk and geopolitical risk.
- **Limited AI expertise:** Talent is one of the biggest challenges to AI. AI requires highly trained and skilled professionals, but being an emerging technology, the talent pool is limited. According to a report, titled 'AI in India - A Strategic Necessity' India only has around 4.5% of the world's AI professionals, and would need about 25,000 to 30,000 artificial intelligence (AI) and machine learning (ML) specialists in the next five years⁶.
- **Lack of AI and cloud computing infrastructure:** AI and cloud are inseparable because AI is data hungry, and cloud is the only possible solution. There are endless possibilities to scale up AI with its convergence with cloud computing. However, despite the potential, India lacks access to specialised compute and storage facilities which forms the backbone of AI. A beginning has been made with India's own AI-first compute infrastructure, [AIRAWAT](#) developed by NITI Aayog, which is a cloud platform for Big Data analytics with advanced AI processing capabilities.
- **Lack of integrity and ethics with AI/ML solutions:** With the advent of AI products and algorithms and their increasing role in decision making, ethics and morality have emerged as a major challenge for the AI solution providers. An AI algorithms work based on training given to it, meaning the AI solution predicts instances based on the data being fed into it and based on the self-learning capability. However, in a few instances, the AI algorithm overlooks the correctness of the data and give an ambiguous result. It is also possible for the results to be skewed due to tampering of the dataset itself⁷.

⁴ <https://www.livemint.com/companies/start-ups/india-ranks-fifth-in-ai-startup-investments-receives-3-24bn-in-2022-stanford-report-11681314138709.html>

⁵ <https://www.blueweaveconsulting.com/report/india-artificial-intelligence-market>

⁶ <https://www.techcircle.in/2023/07/13/india-needs-about-30k-ai-specialists-in-next-5-years-report>

⁷ <https://indiaai.gov.in/article/five-challenges-for-ai-adoption-in-india-and-what-are-we-doing-about-them>

iv. Standardization: AI

Bureau of Indian Standards (BIS):

BIS LITD 30 is responsible for standardization around Artificial Intelligence and Big Data. It is the National Mirror Committee for ISO/IEC JTC1/SC42 with same Title & Scope.

LITD 30 has developed following [standards](#) so far:

1. **IS/ISO/IEC/TR 24028: 2020:** Information technology Artificial intelligence Overview of trustworthiness in artificial intelligence.
2. **IS/ISO/IEC/TR 24029-1: 2021:** Artificial Intelligence AI Assessment of the robustness of neural networks Part 1: Overview
3. **IS/ISO/IEC/TR 24030: 2021:** Information technology Artificial intelligence AI Use cases.
4. **IS/ISO/IEC/TR 24368: 2022:** Information Technology Artificial Intelligence Overview of Ethical and Societal Concerns
5. **IS/ISO/IEC/TR 24372: 2021:** Information technology Artificial intelligence AI Overview of computational approaches for AI systems
6. **IS/ISO/IEC 24668: 2022:** Information technology Artificial intelligence Process management framework for big data analytics
7. **IS/ISO/IEC 38507: 2022:** Information technology Governance of IT Governance implications of the use of artificial intelligence by organizations.

Department of Telecommunications (DoT):

The Department of Telecommunications, Ministry of Communications has formed a committee on standardisation in AI technologies to develop necessary AI standards. The scope of the committee will be mainly to identify the gaps and challenges towards developing the standards in different areas of AI; develop these AI standards with India specific requirements and formulate the framework for AI Indian stack.

There are five working groups working towards standardisation of AI framework.

- **Working Group-1-** Standardisation of the functional network architectures; AI architecture; data structures.
- **Working Group-2-** Standardisation of the type of interfaces and protocols; Technologies employed; Systems deployed; Benchmarking practices.
- **Working Group-3-** Standardisation in Trustworthiness; digital rights and ethical standards in AI; preserving algorithm openness; Security and compliance aspects.
- **Working Group-4-** Standardisation in Interoperability Standards; technological mapping and leveraging AI for national missions.
- **Working Group-5-** Development of Indian AI Stack.

DoT's AI Standardisation Committee released its [Indian AI Stack discussion paper](#) on September 2, 2020, with the intention of mitigating impediments in AI deployment and essentially make AI uniform for application across sectors.

The AI Stack paper highlighted five major horizontal pillars and one main vertical pillar - thus covering some of the most crucial aspects in AI deployment today including security, data storage, privacy, customer experience and computing.

In July 2023, Telecommunication Engineering Centre (TEC), DoT has also unveiled a [Standard \(No. TEC 57050:2023\) for "Fairness Assessment and Rating of Artificial Intelligence Systems"](#). This Standard enumerates detailed procedures for accessing and rating artificial intelligence systems for fairness.

3.3 IoT/M2M

The Indian government has identified M2M communications and the Internet of Things (IoT) among the fastest emerging technologies across the globe, providing enormous beneficial opportunities for the society, industry, and consumers. It is being used to create smart infrastructure in various verticals such as power, automotive, safety and surveillance, remote health management, agriculture, smart homes, Industry 4.0, and smart cities, to name a few, using connected devices. M2M communication is going to play a major role and will contribute significantly towards the government initiatives 'Digital India' and 'Make in India'.

The India IoT connectivity market size reached US\$ 55 Million in 2022. Looking forward, IMARC Group expects the market to reach US\$ 197 Million by 2028, exhibiting a growth rate (CAGR) of 20.3% during 2023-2028. The emerging automation trend in industrial processes, the increasing sales of connected cars, and the widespread adoption of IoT-enabled devices in the healthcare industry represent some of the key factors driving the market⁸.

i. Key policy initiatives

To strengthen the M2M ecosystem and to facilitate wider proliferation and innovation in the sector, the government has taken the following actions recently:

- **[National Telecom M2M Roadmap](#)**: National Telecom M2M Roadmap was released by the Ministry of Communications (MoC) on 12 May 2015. It seeks to assimilate various M2M standards, outline policy and regulatory approaches and measures for increased M2M proliferation.
- **[On 17 January 2022, DoT Introduced new license for UL\(M2M\) and UL-VNO\(M2M\) under UL and UL-VNO licenses and amended the guideline for UL and UL \(VNO\)](#)**: Though the existing Access Service Providers were already enabled to provide connectivity to the M2M/IoT networks, through the new licenses, an independent category of Service Providers has been enabled to create, operate and provide Network for Interconnection of M2M/IoT devices. In this license, applicants can apply for different categories like Category A (For PAN India), Category B (Service Area) and Category C (SSA/District area).

⁸ <https://www.imarcgroup.com/india-iot-connectivity-market#:~:text=The%20India%20IoT%20connectivity%20market,20.3%25%20during%202023%2D2028.>

- **On 8 February 2022, DoT issued [Guidelines for registration of M2MSP Service Providers and WPAN/WLAN Connectivity Providers](#):** Applicants need to register themselves to provide SIM and WPAN/WLAN based M2M Communication. This will help in addressing concerns like connectivity with TSPs, KYC, traceability, and encryption. Registration shall be carried out at field offices of DoT spread across the country.
- **On 16 February 2022, Networks and Technologies wing, DoT set up two [M2M committees](#):** Two committees have been set up: 1) the M2M Policy Reform Committee and 2) the M2M Consultative Committee. They discuss, analyse issues, and suggest initiatives relating to the M2M ecosystem.
- **Released 13-digit numbering plan exclusively for M2M/IoT devices** connected through mobile networks.
- **[Features of the SIMs used only for M2M communication services](#)** have been defined and related KYC instructions for issuing M2M SIMs to entity/organization providing M2M communication under bulk category have also been issued.
- DoT has also permitted use of embedded SIMs by allowing telecom service providers to configure them over the air (OTA). This has enabled availability of sufficient numbering resources and led to a robust framework for mobile M2M ecosystem in the country.
- **On 25 July 2022, TRAI issued [Consultation Paper on Embedded SIM for M2M Communications](#):** In this consultation paper, issues pertaining to holistic deployment of eUICC (Embedded Universal Integrated Circuit Card) in Indian telecom network including implementation mechanism under different profile configurations and switch over of profiles by TSPs have been raised, for consideration and comments of stakeholders.
- **[Addition of 1MHz spectrum to unlicensed 865-867 MHz band](#):** To have additional availability of spectrum for M2M/IoT applications, 1MHz additional spectrum is added in the earlier unlicensed 865-867MHz band, making it 865-868MHz. Also, radiated power, channel bandwidth, and duty cycle have been defined for different use cases.
- Telecom Engineering Centre (TEC) has also released [recommendations on IoT/ M2M security](#) in January 2019, [Code of Practice for securing consumer IoT](#) in August 2021, Technical report on [Framework of National Trust Centre for M2M/ IoT Devices and Applications](#) in March 2022 and Technical Report on [Security by design for IoT device manufacturers](#) in March 2023. These documents suggest ways to have safe and secure IoT deployments. Please [click here](#) for all technical reports in IoT/M2M domain developed by TEC.
 - ✓ TEC code of practice for securing consumer IoT is developed based on **EN 303645**.
- **C-DOT** has developed a [common services platform \(CCSP\)](#) for IoT/M2M communication based on oneM2M Release 3 standards.

The above regulatory enablement for M2M services is expected to reduce cost, enhance the productivity, provide faster response time, optimize the resource consumption, and increase the revenues for businesses, leading to ease of living for the common citizens.

ii. Growth Drivers

Major drivers for IoT market in India are:

- **Increasing adoption of Smart technologies across industries:** The adoption of Smart technologies such as IoT and M2M technologies is increasing across industries, such as healthcare, transportation, and manufacturing, driven by the need for real-time data analysis, improved efficiency, and cost savings.
- **Development of Smart cities and homes:** The rise of smart cities and homes is driving the adoption of M2M/IoT communications, as it enables the integration of various systems, such as lighting, heating, and security, to improve the quality of life for citizens.
- **Low-cost sensors:** Low-cost sensors, declining cost of connectivity as well as reduced cost and time of processing will play a key role in rise and adoption of IoT.
- **Increasing usage of big data analytics:** Use of big data analytics and cloud computing will enable processing and analysis of unstructured data to move from insights to foresights.
- **Growing consumer interest:** Consumer interest in IoT technologies is also rising due to increased reliance on mobile devices and other connected devices.

iii. Challenges

- **Robust connectivity:** It is very important for timely transmission of the data. Latency, availability, coverage, and cost are some of the factors deciding the appropriate communication technology.
- **Security and Privacy:** The increasing connectivity of devices and sensors to the internet has raised concerns about data security and privacy. IoT/M2M security challenges include various aspects of IoT such as authentication, confidentiality, privacy, access control etc.
- **Lack of standardization:** The standardization of the IoT/M2M ecosystem will significantly reduce numerous problems like interoperability, security, data sharing, changing vendors etc. faced by the IoT/M2M ecosystem in the country. It would enable users and application service providers in various domains like Smart Cities, Smart Grids and Meters, Transportation, Health, Energy, Water Resources, Waste Management etc. to use "vendor agnostic" end-to-end interoperable IoT/M2M platforms.
- **Technologies** for sustainability/long life batteries are required for sensors.

iv. Standardization

Bureau of Indian Standards (BIS):

Bureau of Indian Standards (BIS) through its technical committee "LITD 27 on IoT and digital twin" is developing standards in the field of Internet of Things and related technologies including sensor networks. LITD 27 is mirror committee of ISO/IEC/JTC1 TC 41 / SC 41 - Internet of Things and related technologies. Please [click here](#) for the list of standards published by BIS LITD 27.

TSDSI and TEC:

The government of India has adopted international standards set by OneM2M alliance and Release 2 and Release 3 standards were adopted as national standards through TEC, the technical wing of DoT. TSDSI, as partner type 1 of oneM2M has transposed oneM2M Release 2 and Release 3 specifications and had provided these transposed documents to TEC for adoption as national standards. These specifications address the need for common M2M service layer that can be readily embedded within various hardware and software, relied upon to connect the myriad of devices in the field with M2M application servers worldwide. These transposed documents cover M2M functional architecture, requirements, service layer control protocols, Management enablement etc. oneM2M provides a fast-track and future proof IoT based smart city.

These TEC standards have also been included by Bureau of Indian Standards (BIS) in its standards on IoT Reference Architecture released in June 2021.

3.4 Quantum Technologies and High-Performance Computing (HPC)

Quantum technologies are among the most exciting and rapidly developing emergent technologies of the 21st century. India is poised to play a pivotal role in the quantum technology revolution. As per a study by NASSCOM-Avasant, dubbed "[The Quantum Revolution In India](#)", the Indian government is leaving no stone unturned to empower the country's scientific community to take quantum science ahead.

India currently has nearly a hundred quantum projects at present, about 92% of which are sponsored by the Centre. Over the next five years, India plans to invest Rs 8,000 crore (Approx. \$1 billion) to advance research in quantum information and meteorology, quantum applications and materials, and quantum communications.

The NASSCOM-Avasant study also found that Quantum tech potential will provide USD 310B cumulative value add to the Indian economy by 2030 and India is planning to develop a quantum computer with a capacity of 50 qubits by 2026. However, the development of smaller-scale devices (quantum simulators, sensors, etc.) is expected to take place much sooner.

i. Key policy initiatives

Following measures have been taken in India to strengthen quantum industry:

a) National Quantum Mission 2023

With the announcement of National Quantum Mission, India is on the global quantum map. In April 2023, the government has approved the National Quantum Mission (NQM)

at a total cost of Rs.6003.65 crore (approx. €680 Million) from 2023-24 to 2030-31, aiming to seed, nurture and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in Quantum Technology (QT). Through this mission, India has joined an elite club of 6 other nations that have a dedicated quantum mission. These countries include the US, Canada, France, Finland, China, and Australia.

Four Thematic Hubs (T-Hubs) will be set up in top academic and National R&D institutes on the domains of:

- Quantum Computing,
- Quantum Communication,
- Quantum Sensing & Metrology and
- Quantum Materials & Devices

The hubs which will focus on generation of new knowledge through basic and applied research as well as promote R&D in areas that are mandated to them. This mission will be implemented by the Department of Science and Technology (under the Ministry of Science and Technology) in collaboration with others. For more information please [click here>>](#)

b) National Supercomputing Mission

The National Supercomputing Mission (NSM) was launched by Government of India in 2015 and is being implemented jointly by Ministry of Electronics and Information Technology (MeitY), Department of Science and Technology (DST) with Indian Institute of Science, Bangalore and C-DAC being the executing agencies. The National Supercomputing Mission envisages empowering the national academic and R&D institutions spread over the country by installing high-performance computing facilities across the country. A total of 24 petaflops (24 million billion calculations per second) of Supercomputing infrastructure has been already commissioned and another 40 petaflops (40 million billion calculations per second) is envisaged in the coming year based on indigenously designed, developed, and manufactured servers and interconnect.

Application areas:

- Climate Modelling
- Weather Prediction
- Aerospace Engineering including CFD, CSM, CEM
- Computational Biology
- Molecular Dynamics
- Atomic Energy Simulations
- National Security/ Defence Applications
- Seismic Analysis
- Disaster Simulations and Management
- Computational Chemistry
- Computational Material Science and Nanomaterials
- Discoveries beyond Earth (Astrophysics)
- Large Complex Systems Simulations and Cyber Physical Systems
- Big Data Analytics
- Finance
- Information repositories/ Government Information Systems

The project was divided into three phases:

- Phase I involved constructing or assembling supercomputers.
- Phase II involved producing specific elements within the nation.
- Phase III involves building the supercomputer indigenously.

PARAM Shivay, the first supercomputer assembled indigenously, was installed in IIT (BHU), followed by PARAM Shakti, PARAM Brahma, PARAM Yukti, PARAM Sanganak, PARAM Pravega, PARAM Seva, PARAM Smriti, PARAM Utkarsh, and PARAM Ganga. for more information, please [click here>>](#)

c) Quantum-Enabled Science & Technology (QuEST) program

In 2018, India's Department of Science & Technology has set up a program called Quantum-Enabled Science & Technology (QuEST) to develop quantum technology. In what is being described as the Phase 1 of India's quantum computing program, the country will be laying out the basic infrastructure that is needed to promote research in this field. The government believes this will help in improving the state of national security as quantum-level encrypted information becomes a common communication standard.

Following the QuEST programme, India established a national quantum hub — the [I-HUB Quantum Foundation or I-HUB QTF](#) in Pune in 2020 under the dedicated [National Mission on Interdisciplinary Cyber-Physical Systems \(NM-ICPS\)](#) with a budget of INR 170 crore (approx. €19 million) dedicated to the development of QT⁹. [Read more>>](#)

d) Quantum Computing Applications Lab (QCAL)

[Quantum Computing Applications Lab \(QCAL\)](#) was launched by the [Ministry of Electronics and Information Technology \(MeitY\)](#) in collaboration with AWS. QCAL aims to accelerate the adoption of quantum computing in India by providing access to quantum computers, tools, and resources to researchers and developers. For more information, please [click here>>](#)

e) QSim- Quantum Computer Simulator Toolkit

Quantum Computer Simulator Toolkit was launched by the Ministry of Electronics and Information Technology (MeitY) to allow researchers and students to write and debug Quantum Code that is essential for developing Quantum Algorithms and carry out research in in the field in a cost-effective manner. For more information, please [click here>>](#)

ii. Growth Drivers

⁹ <https://blog.mygov.in/editorial/india-ready-to-take-the-lead-in-quantum-tech/#:~:text=Following%20the%20QuEST%20programme%2C%20India,to%20the%20development%20of%20QT.>

- **Increasing adoption quantum technology in various sectors:** The manufacturing, high tech, banking, and defense sectors will likely lead the charge of adopting quantum technologies for critical and large-scale use cases.
- **Favorable Government policies and support:** Policy initiatives such as National Quantum Mission will help to create a vibrant & innovative ecosystem in Quantum Technology (QT). India also plans to spend \$1 billion on a variety of quantum technology initiatives during the next five years, according to NASSCOM.
- **Awareness and Education:** Increasing awareness about the potential of quantum technology and its applications is essential.

iii. Challenges

- **Research and Development:** Quantum technology is a complex and rapidly evolving field, requiring extensive research and development efforts. Factors such as funding for R&D, expertise, and access to advanced infrastructure and equipment pose challenges in adopting quantum technologies.
- **Lack of Skilled Workforce:** Quantum technology demands a highly skilled workforce with expertise in quantum physics, engineering, and related disciplines. Developing and retaining a talented pool of researchers, scientists, and engineers proficient in quantum technologies is a challenge, as it requires specialized training programs, educational initiatives, and collaboration between academia and industry.
- **Insufficient Infrastructure and Resources:** Quantum technology requires advanced infrastructure, including specialized laboratories, fabrication facilities, and high-performance computing resources. Establishing and maintaining such infrastructure is a challenge, as it requires substantial investments and ongoing upgrades to keep pace with advancements in the field.
- **Lack of Standardization and Interoperability:** Quantum technology is still in its nascent stage, and there is a lack of standardized protocols and frameworks. Achieving interoperability among different quantum systems and ensuring compatibility across platforms is a challenge.
- **Ethical and Societal Implications:** Quantum technology raises ethical, legal, and societal considerations. The development and application of quantum technologies, such as quantum computing and cryptography, may have significant societal implications, including data privacy, cybersecurity, and societal disruption. Addressing these concerns and establishing ethical frameworks and guidelines is a challenge.

iv. Standardization: Quantum technology

Bureau of Indian Standards (BIS):

Currently there is no technical committee within BIS developing standards related to quantum technologies.

Telecom Engineering Centre (TEC):

Telecom Engineering Centre (TEC), wing of Telecom Department (DoT) has released following standards in the field of quantum technologies.

- [TEC 91010:2023: Standard for Generic Requirements- Quantum-Safe and Classical Cryptographic Systems](#): The standards for Post Quantum Cryptography system provide the specifications for a cryptographic mechanism to ensure secured communication against vulnerabilities posed with the advent of Quantum computing.
- [TEC 91000:2022: Standard for Generic Requirements- Quantum Key Distribution System](#): This document describes the generic requirements and specifications for Quantum Key Distribution (QKD) systems as per, ITU-T Y.3801-3804 Recommendations for use in Indian telecom network.

3.5 Blockchain

India is also making excellent progress in this sector and participates effectively on a global scale. Reportedly, Blockchain adoption in India could clock 46% by 2026, which indicates vast prospects to boost the local economy. By leveraging the power of blockchain, India can drive significant social impact across various sectors, including healthcare and governance.¹⁰.

i. Key policy initiatives

Following are the key policy initiatives taken by Government on India to promote the blockchain technology:

a) National Strategy on Blockchain

In December 2021, Ministry of Electronics and Information Technology (MEITY) released "[National Strategy on Blockchain](#)" with the vision to create trusted digital platforms through shared Blockchain infrastructure; promoting research and development, innovation, technology and application development; and facilitating state of the art, transparent, secure and trusted digital service delivery to citizens and businesses.

This strategy document lays out overall vision towards development and implementation strategies for a National Blockchain Platform covering the technology stack, legal and regulatory framework, standards development, collaboration, human resource development and potential use cases. It is envisaged that this strategy document would provide the necessary guidance and support for realizing the vision and creating a nationwide ecosystem for creating the National Blockchain Platform and development of relevant applications using this platform in various domains. [Read more/Download>>](#)

¹⁰ <https://www.financialexpress.com/business/blockchain-how-blockchain-is-driving-social-impact-and-transforming-india-3113051/>

b) Draft Discussion Paper on Blockchain: The India Strategy

The leading policy think tank working for the government of India, NITI Aayog, has come out with a strategy document recognising many crucial areas blockchain technology can significantly benefit the country. Known as Blockchain: The India Strategy – Towards Enabling Ease of Business, Ease of Living and Ease of Governance, the 59-page policy paper is the first of two-part papers to be published by NITI Aayog. The first discussion paper covers the basics of distributed technology, its potential framework for India, the implementation challenges, lessons from NITI Aayog’s own PoCs, its use cases, and recommendations for India’s national blockchain strategy. Here are the main takeaways from the Niti Aayog’s discussion Paper:

- **Understanding Blockchain For Government of India:** As part of the document, NITI Aayog recognised Blockchain technology by giving an explainer. It said, “new data can be added to a blockchain only with an agreement between the various nodes of the blockchain network, a mechanism known as distributed consensus. Every node of the distributed network has its own copy of blockchain’s data and checks the other nodes’ data authenticity – if one node changes its local copy, the other nodes reject it. New data is added to the new block, and once added, it is immutable. Older data can neither be deleted nor modified because a snapshot of it is captured in the blocks of data that come after it.” NITI Aayog has conducted PoCs in four areas to assess the power of distributed ledgers in providing enhanced efficiency and improved possible hurdles in execution, like Track and trace’ of drugs in the pharma drug supply chain, claim verification and approval in the disbursement of fertiliser subsidies, verification of university certificates, and transfer of land record ownership. In one of the PoCs for the fertiliser subsidy pilot undertaken by NITI Aayog, the challenge was minimising the turnaround period for reimbursement of subsidies payments and freight claims. The existing workflow was filled with inefficiencies, including multiple systems of record, limited visibility for inventory stocks and low trust in the data created for claim processes.
- **Blockchain Upskilling In India:** According to the paper, there is a dearth of blockchain developers. It said that based on the most aggressive evaluation worldwide, the number of qualified blockchain developers is not more than 10,000 in total, which NITI Aayog discussion paper identifies both as a challenge as well as an opportunity.
 - **Blockchain In Healthcare:** Using blockchain technology for a unified data system, NITI Aayog had another blockchain PoC in India with different partners in the healthcare industry domain. In this context, the pilot was different from the previous pilots as the process was not completely ‘captive’ to one institution and needed large scale coordination for its successful execution. [Read more/Download>>](#)

ii. Growth Drivers

- **Digital Transformation Initiatives:** Businesses in India are increasingly focusing on digital transformation initiatives. Blockchain, with its ability to provide secure and transparent digital transactions, aligns well with these efforts.
- **Government Support and Initiatives:** Initiatives such as the National Strategy on Blockchain aim to leverage blockchain for various sectors, including governance, finance, and supply chain.

- **Growing no. of Blockchain Startups and Innovation:** India has seen a rise in Blockchain startups working on innovative solutions. These startups play a crucial role in driving experimentation and adoption across various industries.

iii. Challenges

- **Lack of Regulation and Compliance:** Lack of regulation and compliance are the most prominent challenge standing in the way of successful adoption of the Blockchain in India.
- **Lack of Awareness and Education:** Lack of a clear understanding of blockchain technology hindering the fast adoption of blockchain technology.
- **Security and data privacy:** The lack of individuals' understanding as to how blockchain-based applications and services can ensure personal data privacy and security reduces their perceived benefits and the public's willingness to adopt them.
- **Skill Shortages:** There is a shortage of skilled professionals in India who are well-versed in blockchain technology. Training and development programs are needed to bridge this gap.

iv. Standardization: Blockchain

Technical committee "[LITD 29: Blockchain and Distributed Ledger Technologies](#)" within Bureau of Indian Standards (BIS) is responsible for developing standards for Blockchain and Distributed Ledger Technologies.

- **IS/ISO 23257: 2022:** Blockchain and distributed ledger technologies Reference Architecture
- **IS/ISO/TS 23258: 2021:** Blockchain and distributed ledger technologies Taxonomy and Ontology
- **IS/ISO/TS 23635: 2022:** Blockchain and distributed ledger technologies Guidelines for governance.
- **IS/ISO/TR 3242: 2022:** Blockchain and distributed ledger technologies- Use cases.

3.6 Cybersecurity/Data privacy

India's digital economy is growing rapidly, and technology adoption is in every facet of human intervention. India's core digital sectors accounted for about EUR 170 billion or 7 % of GDP in 2017-18, and this is expected to grow to 8%-10% of GDP by 2025¹¹. India could create up to and estimated EUR 1 trillion of economic value from the digital

11

https://www.dsci.in/sites/default/files/documents/resource_centre/National%20Cyber%20Security%20Strategy%202020%20DSCI%20submission.pdf

economy in 2025, with half of the opportunities originating in new digital ecosystems¹². As the digital economy grows, it becomes more prone to cyber threats and vulnerabilities.

According to a survey conducted by CyberArk, a global identity security company, revealed that 91% of Indian organizations surveyed by the agency have experienced ransomware attacks in 2022¹³. According to Indian Computer Emergency Response Team, India registered a staggering 3.63 million cybersecurity events from January 2019 to June 2022.

i. Key policy initiatives

To fight the increasing cyber threat, Government of India (GoI) has taken several technical, institutional, and legislative steps which include:

c) The Information Technology Act 2000

The Information Technology Act, 2000 was enacted by the Indian Parliament in 2000. It is the primary law in India for matters related to cybercrime and e-commerce. An amendment was passed by Parliament in December 2008 ("Amendment Act").

d) Digital Personal Data Protection Act, 2023

The Digital Personal Data Protection (DPDP) Act was notified in the Official Gazette on 11 August 2023. The act borrows its broad definition of personal data from the EU's General Data Protection Regulation (GDPR) and aims to protect data principals and restrict the activities of data fiduciaries.

The primary objective of the Act is to establish a comprehensive framework for the Protection and Processing of Personal Data.

"The Act provides for the processing of digital Personal Data in a manner that recognizes both the rights of the individuals to protect their Personal Data and the need to process such Personal Data for lawful purposes and matters connected therewith or incidental thereto".

The Act shall apply to the processing of Personal Data in India, including both online and digitized offline data, and shall further extend to the processing of such data outside India relating to the offering of goods or services in India.

The Act also lays the foundation for various other laws such as the Digital India Act and other industry-specific laws around privacy and data protection to augment India's march towards the adoption of Artificial Intelligence (AI) and other future technologies while protecting *Personal Data*. The Act may also aid Indian businesses to enhance collaboration with other businesses located internationally under reciprocal arrangements while safeguarding *Personal Data*.

For more information, please [click here>>](#)

¹² https://www.meity.gov.in/writereaddata/files/india_trillion-dollar_digital_opportunity.pdf

¹³ https://www.business-standard.com/industry/news/91-of-indian-organisations-experienced-ransomware-attacks-in-2022-report-123061600894_1.html

e) National Cyber Security Policy-2013

Government of India released National Cyber Security Policy in 2013 with aims at (1) facilitating the creation of secure computing environment (2) enabling adequate trust and confidence in electronic transactions and (3) guiding stakeholders' actions for the protection of cyberspace.

The salient features of the policy cover the following aspects:

- A vision and mission statement aimed at building a secure and resilient cyber space for citizens, businesses, and the Government.
- Enabling goals aimed at reducing national vulnerability to cyber-attacks, preventing cyber-attacks and cybercrimes, minimizing response and recover time and effective cybercrime investigation and prosecution.
- Focused action at the level of Government, public-private partnership arrangements, cyber security related technology actions, protection of critical information infrastructure and national alerts and advice mechanism, awareness & capacity building and promoting information sharing and cooperation.
- Enhancing cooperation and coordination between all the stakeholder entities within the country.
- Objectives and strategies in support of the National cyber security vision and mission.
- Framework and initiatives that can be pursued at the Govt. level, sectoral levels as well as in public private partnership mode.
- Facilitating monitoring key trends at the national level such as trends in cyber security compliance, cyber-attacks, cyber-crime, and cyber infrastructure growth.

"The Indian Government under the aegis of National Security Council Secretariat is reportedly in the final stage of approval of the National Cyber Security Strategy 2023 (NCSS 2023). As a first follow up to MEITY's NCSP 2013, Government has approved National Cyber Security Reference Framework (NCRF) 2023 and it will be placed in public domain soon¹⁴.

For more information about NCSP 2013, please [click here>>](#)

f) The Indian Computer Emergency Response Team (CERT-In)

CERT-In is India's national agency for cybersecurity. In IT Amendment ACT 2008, CERT-In has been designed to serve as the national agency to perform the following functions around cyber security:

- Collection, analysis, and dissemination of information on cyber incidents
- Forecast and alerts of cyber security incidents.
- Emergency measures for handling cyber security incidents
- Coordination of cyber incident response activities
- Issue guidelines, advisories, vulnerability notes and whitepapers relating to information security practices, procedures, prevention, response and reporting of cyber incidents.
- Such other functions relating to cyber security as may be prescribed.

¹⁴ <https://www.livemint.com/technology/govt-prepares-new-cyber-security-policy-to-beat-malware-attacks-11686717816691.html>

Recently, CERT-In issued "[Guidelines on Information Security Practices for Government Entities for Safe & Trusted Internet](#)". These guidelines are a roadmap for the Government entities and industry to reduce cyber risk, protect citizen data and continue to improve the cyber security ecosystem in the country. They will serve as a fundamental document for audit teams, including internal, external, and third-party auditors, to assess an organisation's security posture against the specified cybersecurity requirements. The guidelines include various security domains such as network security, identity and access management, application security, data security, third-party outsourcing, hardening procedures, security monitoring, incident management, and security auditing.

For more information, please [click here>>](#)

g) Cyber Surakshit Bharat

An initiative from MeitY in association with National e-Governance Division (NeGD) and industry partners, Cyber Surakshit Bharat aims to ensure awareness about cybercrime and adequate safety measures for Chief Information Security Officers (CISOs) and frontline IT staff across all government departments. This first public-private partnership also includes a series of workshops to help officials become knowledgeable about cybersecurity and equip them with toolkits for fighting cyber-threats.

h) National Critical Information Infrastructure Protection Centre (NCIIPC)

As a part of Indian Government Initiatives on Cybersecurity to safeguard critical information relevant to national security, economic development, and public health, India established in 2014 the National Critical Information Infrastructure Protection Centre. Information Technology (IT) Act, 2000, Section 70A, amended this provision. Cybersecurity exercises are conducted by this organization to make sure the government and critical sectors are prepared in terms of cybersecurity.

i) Cyber Swachhta Kendra (Botnet Cleaning and Malware Analysis Centre)

The " Cyber Swachhta Kendra " (Botnet Cleaning and Malware Analysis Centre) is a part of the Government of India's Digital India initiative under the Ministry of Electronics and Information Technology (MeitY) to create a secure cyber space by detecting botnet infections in India and to notify, enable cleaning and securing systems of end users to prevent further infections. The " Cyber Swachhta Kendra "is set up in accordance with the objectives of the "National Cyber Security Policy", which envisages creating a secure cyber eco system in the country. This centre operates in close coordination and collaboration with Internet Service Providers and Product/Antivirus companies. This website provides information and tools to users to secure their systems/devices. This centre is being operated by the Indian Computer Emergency Response Team (CERT-In) under provisions of Section 70B of the Information Technology Act, 2000. For more information, please [click here>>](#)

ii. Growth drivers

- **Growing no. of cybersecurity startups:** India has a thriving startup ecosystem, and there is a growing number of companies focused on providing cybersecurity solutions to individuals and organizations. These startups have the potential to not

only address the cybersecurity needs of the country but also to become global leaders in the field.

- **Increasing use of technology in various sectors:** With the proliferation of the internet and the adoption of digital technologies, virtually every sector in the country is now reliant on technology. This includes sectors such as finance, healthcare, transportation, Energy, and manufacturing etc., which are particularly sensitive to cyber-attacks. As a result, there is a growing demand for cybersecurity solutions to protect against these threats.
- **India is emerging as a hub for cyber GCCs (Global Capability Centres):** The number of cyber GCCs has increased by 30% since 2018. Key factors driving this trend are the availability of cybersecurity skills, round-the-clock delivery, cost arbitrage, proximity to other business functions and innovation, and research and development. Cyber GCCs have more than 40% of cyber GCCs deliver part of all cybersecurity functions from India¹⁵.
- **Increased contribution of private sector:** Although India's central government has been slow in addressing cybersecurity, the private sector has been far more active and effective. The DSCI, which promotes best practices and standards for cybersecurity and privacy, undertakes capacity-building projects with a focus on training and certification, including for the government sector. **The private sector is leading the way in developing strong policies and standards.**

iii. Challenges

- **Ransomware on the Rise:** Ransomware attacks are becoming more frequent and costly, with over 75% of Indian organizations having faced such attacks and each breach costing an average of ₹35 crore (~4 million Euro) of damage¹⁶.
- **Lack of Infrastructure** –The cybersecurity infrastructure in India is still developing, and there is a need for robust systems and frameworks to address emerging threats effectively. This includes implementing strong network security, data protection measures, and incident response capabilities.
- **Lack of Cybersecurity Regulations:** India is working towards strengthening cybersecurity regulations, but there are still gaps and challenges in implementing comprehensive legal frameworks and enforcing them effectively. This includes areas such as data protection, privacy regulations, and cybercrime laws.
- **Rapid adoption of Emerging Technologies:** The rapid adoption of emerging technologies, such as IoT/M2M, cloud computing, and AI etc., introduces new vulnerabilities and challenges. Ensuring the security of these technologies and addressing the associated risks is a significant concern.

¹⁵ <https://assets.kpmg/content/dam/kpmg/in/pdf/2020/12/secure-in-india-2020.pdf>

¹⁶ <https://www.thehindu.com/opinion/op-ed/cyberattacks-are-rising-but-there-is-an-ideal-patch/article66550210.ece>

- **Shortage of skilled professionals:** While there is a growing demand for cybersecurity experts, there are not enough trained professionals to meet this demand. India is expected to face a shortage of around 3 million cybersecurity professionals by the end of 2023.
- i. **Lack of awareness and education:** Many individuals and organizations in the country still do not fully understand the risks and implications of cyber-attacks, leaving them vulnerable to exploitation. This is particularly true for smaller businesses and startups that may not have the resources to invest in robust cybersecurity measures.

iv. Standardization

BIS LITD 17 on Information Systems Security and Privacy

Bureau of Indian Standards (BIS) through its technical committee "LITD 17 on Information systems security and privacy" is developing standards in the field of Security and Privacy aspects of Information Systems. LITD 17 is the national mirror committee for ISO/IEC TC-JTC 1 SC-27 (P) on *Information security, cybersecurity, and privacy protection*.

BIS LITD 17 has adopted ISO 27000 series of standards. Please [click here](#) for the list of standards published by LITD 17.

3.7 Electronic/Digital signature

i. Key Policy Initiatives

In India, electronic and certificate-based digital-signatures are regulated by the Information Technology Act, 2000 (IT Act) and the following rules made under this Act:

- [Information Technology \(Certifying Authorities\) Rules, 2000](#);
- [Digital Signature \(End Entity\) Rules, 2015](#); and
- Information Technology (Use of Electronic Records and Digital Signature) Rules, 2004.

The IT Act distinguishes between electronic signatures and certificate-based digital signatures, but both have the same status as handwritten signatures under Indian law.

Valid electronic signatures must include an electronic authentication technique or procedure specified in the Second Schedule of the IT Act. The Second Schedule currently specifies the following e-KYC (Know Your Customer) authentication techniques and procedures:

1. Aadhaar e-KYC
2. Other e-KYC services (e.g. e-KYC using Permanent Account Number (PAN)).

Under Indian law, reliable electronic and digital signatures carry a presumption of validity compared to other "non-recognized" electronic signatures. However, in common with

other jurisdictions, Indian law will not consider an agreement invalid solely on the grounds that it was formed with such non-recognised electronic signatures.

For an electronic signature to be considered reliable and presumptively valid under the IT Act:

1. It must be unique to the signatory.
2. at the time of signing, the signatory must have control over the data used to generate the electronic signature.
3. any alteration to the affixed electronic signature, or to the document to which the signature is affixed, must be detectable.
4. there should be an audit trail of steps taken during the signing process; and
5. The signer certificates must be issued by a certifying authority (CA) recognized by the Controller of Certifying Authorities appointed under the IT Act. A list of licensed CAs is available at http://www.cca.gov.in/licensed_ca.html¹⁷.

ii. Growth Drivers

- **Growth in paperless transactions:** The trend towards paperless transactions and the reduction of paper-based processes has led to an increase in the demand for digital signatures.
- **Awareness among consumers:** With the increasing awareness about the benefits of digital signatures, more businesses are adopting this technology for their transactions.
- **Cost-effectiveness and time saving** of digital signatures compared to traditional paper-based signatures, as they reduce the need for printing, mailing, and storage of physical documents. Businesses can also save on courier and postage expenses.¹⁸.

iii. Challenges

- **Lack of Awareness and Adoption:** There seems to be lack of awareness and education about digital signature, digital signature certificates and their adoption and usage. Raising awareness and providing education on their use is crucial.
- **Security & privacy concerns:** Risks associated with the security and integrity of digital signatures, such as unauthorized access, data breaches, or forged signatures, pose challenges to their widespread adoption. The misuse of digital signatures can have serious consequences, as it can lead to fraud and identity theft. Implementing robust security measures and encryption protocols helps address these concerns.

iv. Standardization

¹⁷ <https://helpx.adobe.com/legal/esignatures/regulations/india.html>

¹⁸ <https://www.globenewswire.com/en/news-release/2023/01/30/2598004/0/en/Digital-Signature-Market-Size-Growing-at-35-4-CAGR-Set-to-Reach-USD-48-4-Billion-by-2030.html#:~:text=Growth%20in%20paperless%20transactions%3A%20The,friendly%2C%20leading%20to%20increased%20adoption.>

Within BIS, technical committee **SSD10: IT & IT enabled Services** is responsible for Standardization in the field of Services, Processes, Supporting Frameworks, Management and Governance for the provisioning of IT and IT Enabled Services in areas such as (but not limited to), contract management, performance management, procurement management, customer satisfaction, contact centre, covering existing and emerging digital and automation technologies.

- This technical committee has drafted "SSD 10 (21410): Electronic Signatures and Infrastructures ESI Policy and Security Requirements for Applications for Signature Creation and Signature Validation" which is a technical adoption of the European Standard EN 119 101 V1.1.1 (2016-03) "Electronic Signatures and Infrastructures (ESI); Policy and security requirements for applications for signature creation and signature validation" developed by ETSI.

For more information, please [click here>>](#)

3.8 E-accessibility

As India's digital landscape continues to grow and evolve, ensuring that digital content and services are accessible to all users, including those with disabilities, has become increasingly important. As per Indian Census 2011, 2.21% of India's population are PwDs.

i. Key policy initiatives

The Government of India has taken following step to improve e-accessibility and promote a more inclusive digital ecosystem in the country.

a) The Rights of Persons with Disabilities Act, 2016

In India, the Rights of Persons with Disabilities Act, 2016 (RPWD Act, 2016) mandates equal rights and opportunities for people with disabilities and requires the government to take measures to promote accessibility. It covers various aspects, including physical infrastructure, transportation, and ICT.

As per the RPWD Act, 2016 twenty-one (21) types of disabilities have been recognized and listed. The Act clearly states that the central government shall, in consultation with the chief commissioner, formulate rules for PwDs, laying down the standards of accessibility for physical environment, transportation, Information and communication, including appropriate technologies and systems, and other facilities and services provided to the public in urban and rural areas.

The RPWD Act mandates to notify standards for accessibility of technologies and communication and promote universal design in electronics goods. For more details of RPWD Act, 2016, please [click here>>](#)

[More information>>](#)

b) Guidelines for Indian Government Websites, 2009

The Ministry of Electronics and Information Technology (MeitY) has issued guidelines for Indian government websites to ensure that they are accessible to people with disabilities. Public entities in India must follow the "[Guidelines for Indian Government Websites, 2009](#)", which include considerations for accessibility along with guidance intended to standardize the on-page experience across different government websites.

These Guidelines are based on International Standards including ISO 23026, W3C's Web Content Accessibility Guidelines (WCAG 2.0) Rights of Persons with Disabilities Act 2016 as well as Information Technology Act of India.

Many of WCAG criteria closely correlate with these standards, and sites that conform with WCAG Level AA can meet the document's accessibility requirements. However, because the Guidelines for Indian Government Websites contain specific requirements for page design, CSS implementation, and information architecture, WCAG conformance does not ensure full compliance. For more information please [click here>>](#)

c) Accessible India Campaign (Sugamya Bharat Abhiyan):

Department of Empowerment of Persons with Disabilities (DEPwD) launched Accessible India Campaign (Sugamya Bharat Abhiyan) as a nation-wide Campaign for achieving universal accessibility for Persons with Disabilities (PwDs) on December 3, 2015. It has three important verticals, namely - the Build Environment, the transportation sector, and the ICT ecosystem.

Components of Accessible India Campaign:

- **Built Environment Accessibility:** The Accessible India Campaign aims to provide an accessible physical environment to everyone. To achieve this, measures need to be undertaken to eliminate obstacles and barriers to indoor and outdoor facilities including schools, medical facilities, and workplaces. The built environment not only covers buildings, but also steps and ramps, corridors, footpaths, curb cuts, parking, entry gate, emergency exits, toilets and obstacles that block the flow of pedestrian traffic.
- **Transportation System Accessibility:** Transportation is a vital component for independent living. The term transportation covers several areas including air travel, buses, taxis, and trains. Inaccessible transportation system restricts mobility, denies freedom of movement and active participation, for much of the population who may need accessible transportation. The Accessible India Campaign focuses on providing persons with disabilities an equal right to travel and use public and private transportation infrastructure with dignity and independence.
- **Information and Communication Eco-System Accessibility:** Access to information creates opportunities for everyone in society. Access to information refers to all information. This can range from actions such as being able to read price tags, to physically enter a hall, to participate in an event, to read a pamphlet with healthcare information, to understand a train timetable, or to view webpages. The Accessible India Campaign aims to take measures to curb all societal barriers of infrastructure, and inaccessible formats that stand in the way of obtaining and utilizing information in daily life.

For more information, please [click here>>](#)

ii. Standardization

Bureau of Indian Standards (BIS) through its technical committee **LITD-35: Active Assisted Living (AAL)** is developing standards in the field of accessibility. LITD 35 is responsible for standardization around accessibility, interoperability of AAL systems, services, products, and components; and standardization of system level aspects of AAL such as safety, security, and privacy.

- [IS 17802 \(Part 1\): 2021](#): Accessibility for the ICT Products and Services Part 1: Requirements
- [IS 17802 \(Part 2\): 2022](#): Accessibility for the ICT Products and Services Part 2: Determination of Conformance
- [IS 1885 \(Part 89\): 2023/IEC 60050-871: 2021](#): Electrotechnical vocabulary Part 871: Active assisted living AAL.
- [IS/IEC/TS 63134: 2020](#): Active assisted living AAL use cases.

The IS 17802 (part 1 and 2) is based on the European Standard EN 301 549 v 3.2.1.

3.9 Smart Cities/Urban Development

Urban areas in **India** accommodate around 31% of the population and contribute to 63% of the country's GDP, according to the 2011 Census data. It is projected that by 2030, the urban population will rise to approximately 40%, contributing as much as 75% to the GDP.

i. Key policy initiatives

To improve the quality of life in cities and towns across the nation, Government of India has launched various initiatives as given below:

a) [Smart City Mission](#)

The Government of India launched the Smart Cities Mission on 25th June 2015, with an objective to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions.

Some of the core infrastructure elements in a Smart City would include adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, affordable housing, especially for the poor, robust IT connectivity and digitalization, good governance, especially e-Governance and citizen participation, sustainable environment, safety and security of citizens, particularly women, children and the elderly and health and education.

- The strategic components of the Smart Cities Mission are city improvement (retrofitting), city renewal (redevelopment) and city extension (Greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city.

Enabling Europe-India Cooperation on Standards

- Area-based development will transform existing areas (retrofit and redevelop), including slums, into better planned human settlements, thereby, improving liveability of the whole cities. Development of well-planned and fully serviced new areas (greenfield) will be encouraged around cities to accommodate the rapidly expanding population in urban areas. Application of Smart Solutions will enable cities to use technology to improve infrastructure and services.

The selection process of Smart Cities was based on the idea of Competitive and Co-operative Federalism and followed a Challenge process to select cities in two stages. The government has selected [100 cities](#) through a City Challenge Process in five rounds.

As per the [data available](#) at the Ministry of Housing and Urban Affairs (MoHUA) website, as of 11 September 2023, work orders have been issued by 100 Smart Cities in 7,934 projects, of which 6,069 projects (76%) have been completed. The total cost of these SCM projects comes to Rs 1,71,044 crore (approx. €19 billion), while the initial total estimate was Rs 2.05 lakh crore (approx. €22.7 billion), of which less than a half would be funded by the governments, and the balance to be mobilized from internal or external sources, and other central government schemes.

The Union Housing and Urban Affairs Ministry has extended the deadline for the Smart Cities Mission until June 2024.

Please [click here](#) to know more about the status of projects in each city selected under Smart City Mission.

For more details on the commencement of Smart City Mission in India, please refer / download previous SESEI report on "[Smart City Mission, India](#)".

b) [Open Data Platform/India Urban Data Exchange \(IUDX\)](#)

The '[India Urban Data Exchange \(IUDX\)](#)' initiative is a collaboration between the Smart Cities Mission and the Indian Institute of Science (IISc), Bengaluru. IUDX has been developed to facilitate secure and authenticated exchange of data amongst various data platforms, 3rd party applications, data producers and consumers, both within a city to begin with, and scaled up across cities eventually at a national level, in a uniform & seamless way. The platform will provide full control to the data owners as to what data to expose and to whom. Built-in accounting mechanisms will enable it to connect with payment gateways which will form the foundation for a data marketplace. The whole platform will be developer friendly, via definitions of open APIs and data schema templates (formats for interpreting data), so that a whole new application ecosystem gets created.

IUDX has also become the first software platform in the country to fully adhere to the Architecture and API Specifications set by the Bureau of Indian Standards (BIS) for data exchange platforms. The Unified Data Exchange standard – IS 18003, is part of a series of 10 indigenous standards developed by BIS Smart Infrastructural Sectional Committee (LITD 28) for Indian Smart Cities to ensure a secure and sustainable digital infrastructure and to facilitate the implementation of various smart city projects. The

foundational standard for this series is "IS 18000 Unified Digital Infrastructure – ICT Reference Architecture (UDI-ICTRA)"¹⁹. For more information please [click here>>](#)

c) [National Urban Digital Mission](#)

National Urban Digital Mission aims to build the shared digital infrastructure that will strengthen the capacity of the urban ecosystem to solve complex problems at scale and speed. On February 23, 2021, the central government launched the '[National Urban Digital Mission](#)' to establish a digital infrastructure to formalise a citizen-centric and ecosystem-driven approach to urban governance and service delivery in cities by 2022. It is built as a public good and provides the ecosystem actors the foundational digital building blocks, ready-to-use platforms, standards, specifications, and frameworks. Examples include India Urban Data Exchange (IUDX), which is an open-source platform that will provide data on numerous urban indicators. **Smart Cities Open Data Portal** is another example, being created to develop products and build solutions and SmartCode, which will serve the software development demand of cities, providing data and solutions for various urban problems. For more information please [click here>>](#)

d) [Smart City Living Labs](#)

The Smart City Living Lab, an open-innovation ecosystem has been set up at IIITH, with support from the MEITY, Smart City Mission and Government of Telangana and in collaboration with the technology partners EBTC and Amsterdam Innovation Arena to discover & develop cutting edge innovations with smart city use cases and enrich them with the knowledge from research.

The primary goal of this innovation initiative is to enable discovering, sourcing, validating, proving, and taking to production, the various Smart City innovations, solutions, and products. And bringing in the key stakeholders- governments, research, start-ups, tech companies, smart city players and policy makers.

The IIITH campus would include different IoT verticals related to air quality, building energy, water quantity and quality, street lighting, etc. For more information, please [click here>>](#)

e) [Common Service Platform developed by C-DOT \(Centre for Development of Telematics\)](#)

The Centre for Development of Telematics (C-DoT), an Indian Government owned telecommunications technology development centre, has also developed CCSP (C-DOT Common Service Platform), the oneM2M standards compliant common service platform which can be deployed on any off-the-shelf generic server platforms or cloud infrastructure. The business application providers can deploy their oneM2M compliant applications in either co-located infrastructure or on any public or private cloud.

Using the CCSP platform from C-DOT, the smart cities can reap all the benefits of using a standards compliant horizontal service layer and thus be more efficient, economical, and future proof. Along with the CCSP, C-DOT has also developed various oneM2M

¹⁹ <https://iudx.org.in/iudx-becomes-first-software-platform-to-fully-adopt-bis-standards-for-unified-data-exchange/>

indigenously designed hardware nodes like AND (Application Dedicated Node), ASN (Application Service Node) and MN (Middle node).

To effectively showcase the strength of the platform, C-DOT has also developed various applications like Smart Living, Smart Street Light, Carbon Footprint Monitoring Application and Power Monitoring which are fully oneM2M compliant. [Read more>>](#)

The Ministry of Housing and Urban Affairs (MoHUA), Government of India has also initiated several other programmes to support the Smart City Mission and Urbanization in the country. Please [click here](#) for the more details.

ii. Growth Drivers

- **Economic Development and Growing urbanization:** Smart Cities can attract businesses, increase economic growth, and create job opportunities with the use of technology and data-driven decision making. As India has a rapidly growing urban population, there is growing need for efficient and sustainable urban infrastructure and services.
- **Growing adoption of emerging technologies:** There has been a rapid increase in the adoption of new and emerging technologies in India, including IoT/M2M, Big Data, cloud computing etc. to improve urban efficiency.
- **Government support:** Government Support and technological advancements have been key drivers for smart cities in the country. The government has made significant investment and has launched several initiatives such as Smart city Mission to modernize cities and improve the quality of life for citizens.

iii. Challenges

- **Privacy and Data security:** The extensive use of sensors, cameras, and connected devices generates vast amounts of data about citizens' movements and activities. Ensuring that this data is collected, stored, and utilized ethically and securely is crucial to prevent misuse and protect individuals' rights.
- **Advanced Technology Solutions:** Most of the Technology solutions in the Smart City space belong to the advanced technology category. Take for example "Internet of Things" (IoT) based data acquisition and analysis, Advanced data analytics using Artificial Intelligence and Machine Learning, Integration of voluminous data from across varied domains into a Command-and-Control centre, Use of advanced Video technology and real time systems for different domains. While the implementing agencies need not get into the details of these technologies, there is a need for them to at least know the nuances of these technologies. However, such working knowledge of these technologies is clearly missing from the smart City Practitioners in the field.
- **Urban resilience:** Relying heavily on technology can make cities vulnerable to cyber- attacks, power outages, or system failures. Smart cities need robust backup

plans and disaster management strategies to ensure their functionality during crises.

- **Interoperability and standardization:** Smart cities involve multiple systems and services from various vendors and stakeholders. The lack of standardization can lead to compatibility issues, hindering the seamless integration of these technologies, which, in turn, might limit the effectiveness of smart city initiatives.
- **Financial burden:** the financial burden of implementing smart city technologies can be immense. Investments in infrastructure, IoT devices, and data analytics require substantial funding, and many cities face budget constraints, making it challenging to embark on large-scale smart city projects²⁰.

iv. Standardization

The main element that allows infrastructures to link and operate efficiently is standards as they make technologies interoperable and efficient. Developing national standards in line with these international standards would enable interoperability (i.e., devices and systems working together) and provide a roadmap to address key issues like data protection, privacy and other inherent risks in the digital delivery and use of public services in the envisioned smart cities, which call for comprehensive data management standards in India to instil public confidence and trust.

The Bureau of Indian Standards (BIS) has embraced the vision of Smart Cities and has embarked on an ambitious journey to develop a comprehensive set of standards for Smart cities, covering all aspects of the Information and Communication Technologies (ICT), pertaining to Smart Cities. These include an overall master document, the ICT Reference architecture, followed by a host of standards to cover, Data and associated technologies, Geographical Information Systems (GIS), Internet of Things (IoT) technologies, Communication protocols, E-governance Systems and Data models and Taxonomy standards for all the relevant domains for Smart Cities.

So far BIS, with the help of the Ministry of Housing and Urban Affairs, and other stakeholders such as system integrators, vendors, solution providers has published [10 indigenous standards](#) under one of its technical committees, namely, "[Smart Infrastructure Sectional Committee LITD 28](#)".

Following are the standards published so far²¹:

1. **IS 18000:2020** Unified Digital Infrastructure – ICT Reference Architecture (UDI-ICTRA)
2. **IS 18002 (Part 1):2021** Unified Digital Infrastructure – Data Layer Part 1 Reference Architecture

²⁰ <https://egov.eletsonline.com/2023/09/smart-cities-and-digital-transformation-building-a-sustainable-future/>

²¹ https://www.services.bis.gov.in/php/BIS_2.0/BISBlog/indian-standards-on-smart-cities-triggering-standards-based-technology-adoption-in-smart-cities/#:~:text=These%20include%20an%20overall%20master,models%20and%20Taxonomy%20standards%20of
or

3. **IS 18003 (Part 1):2020** Unified Data Exchange Part 1 Architecture.
4. **IS 18003 (Part 2):2021** Unified Data Exchange Part 2 API Specifications
5. **IS 18004 (Part 1):2021** IoT System Part 1 Reference Architecture
6. **IS 18006 (Part 1):2021** Municipal Governance Part 1 Reference Architecture
7. **IS 18006 (Part 3/Sec 1):2021** Municipal Governance Part 3 Property Tax Section 1 Taxonomy
8. **IS 18008 (Part 1):2021** Smart Cities – GIS Part 1 Reference Architecture
9. **IS 18010 (Part 1):2020** Unified Digital Infrastructure – Unified Last Mile Communication Protocols Stack Part 1 Reference Architecture.
10. **IS 18010 (Part 5/Sec 1):2020** Unified Digital Infrastructure – Unified Last Mile Communication Protocols Stack – Part 5 Network Access Layer (IEEE 802.15.4) Section 1 Specification.

IoT Reference Architecture, **IoT RA IS 18004 (Part 1): 2021** is based on oneM2M CSF and Unified Data Exchange Part 2 API specifications (IS 18003: Part 2: 2021) includes NGSI-LD (ETSI CIM).

The Bureau of Indian Standards (BIS) through its technical committee “CED 59 on Smart Cities” under the Civil Engineering Department, has also formulated standards in the field of Smart Cities terminology, components, planning, design, integration, implementation, operation, maintenance, and assessment. Following are the [standards published](#) so far:

1. **IS 17000: 2019:** Sustainable Development of Habitats - Indicators.
2. **IS 17451: 2020:** Smart Community Infrastructure - Best Practices for Transportation – Guidelines
3. **IS 17456: 2020:** Smart Community Infrastructure - Guidance on Smart Transportation for Allocation of Parking Lots in Cities
4. **IS 17457: 2020:** Sustainable Development of Habitats – Vocabulary
5. **IS 17738: 2022:** Sustainable development of habitats - Indicators for smart cities.
6. **IS 17785: 2022:** Sustainable development of habitats - Indicators for resilient cities.

Two other standard developing organizations in ICT/Telecom sector in India i.e. TSDSI and TEC, DoT have also been working towards developing standards in the field of ICT/Smart Cities.

TSDSI works closely with global standards’ bodies (3GPP, oneM2M, ETSI, etc.) to reflect Indian requirements into international telecom/ICT standards. TSDSI [transposed](#) oneM2M Release 2 and Released 3 specifications and submitted it to TEC/DoT for considering them for National adoption / ratification. TEC, after complying with the due consultation process and as per the Standardization guide, adopted TSDSI-transposed oneM2M Release 2 and Release 3 specifications as National standards. These standards will be quite useful for the development of interoperable ecosystem for IoT domain, especially for Smart cities.

These national standards shall remain voluntary unless made mandatory for its use, reference, or adoption by regulation / Govt. directive.

3.10 Smart Grid/Meter

The implementation of [smart grid technology](#) is the need of the hour to meet consumer requirements for secure, reliable, and affordable supply as well as to balance the electricity grid with the increasing penetration of renewable energy sources. Smart Grids can be achieved by implementing efficient transmission & distribution systems, system operations, consumer integration and renewable integration. Smart grid solutions help to monitor, measure and control power flows in real time that can contribute to identification of losses and thereby appropriate technical and managerial actions can be taken to arrest the losses.

Smart grid solutions can contribute to reduction of T&D losses, Peak load management, improved quality of Service, increased reliability, better asset management, renewable integration, better accessibility to electricity etc. and lead to self-healing grids.

Realizing the increasing importance of smart grid, the Indian government in 2011 established "[India Smart Grid Forum \(ISGF\)](#)", a public-private partnership, to accelerate electric grid modernization and energy transition in India.

i. Key policy initiatives

Government of India has also launched following policy initiatives to implement smart Grid/Meter:

a) Smart Grid Vision and Road map for India

In 2013, Ministry of Power (MoP) has released "Smart Grid Vision and Road map for India" that offers a series of time-framed, specific, target driven measures, across these different areas, with which to enable the development of an Indian Smart grid model. The roadmap had been prepared by the India Smart Grid Task Force (ISGTF) and India Smart Grid Forum (ISGF), and covers the 12th, 13th, and 14th 5-year plan periods from 2012 to 2027. [Read more about SG Vision and Roadmap for India>>](#)

b) National Smart Grid Mission (NSGM)

Ministry of Power (MoP) launched National Smart Grid Mission in 2015 with aims to accelerate Smart Grid deployment in India. NSGM has its own resources, authority, functional & financial autonomy to plan and monitor implementation of the policies and programs related to Smart Grids in the country.

NSGM functions with [three tier hierarchical structure](#): 1st Level – [Governing Council \(GC\)](#), headed by Minister of Power, 2nd Level – [Empowered Committee \(EC\)](#), headed by Secretary (Power), Supportive Level – [Technical Committee \(TC\)](#), headed by Chairperson CEA, 3rd Level – [NSGM Project Management Unit \(NPMU\)](#).

There are [12 Smart Grid pilot projects](#) approved under NSGM so far, adopting the functionalities such as Advanced metering infrastructure, Peak Load Management, Cybersecurity, Distributed generation, Micro grid, Power quality measurement, Smart City Control Center, Smart homes, Advanced IT infrastructure, Renewable Energy Integration, EV with charging infra, Home energy management center, AMI (Smart Metering), Outage management system, Customer engagement social media for utility.

According to the National Smart Grid Mission as of September 30, 2023, a total of 23 crore (230 million) [smart consumer meters](#) have been sanctioned on a pan-India basis, of which, orders for 7.95 crore (79.5 million) meters have been awarded so far. A total of 70.32 lakh smart meters have been installed so far. These smart metering projects were sanctioned under [RDSS \(Revamped Distribution Sector Scheme\)](#), [DDUGYJ \(Deen Dayal Upadhyaya Gram Jyoti Yojana\)](#), [IPDS \(Integrated Power Development Scheme\)](#), [NSGM \(National Smart Grid Mission\)](#), [SG Pilot](#), PMDP (Prime Minister Development Package) scheme, and under the utility ownership model.

Read more about NSGM [here>>](#)

ii. Growth Drivers

Here are some of the key growth drivers for smart grid/meter in India:

- **Energy Efficiency:** Smart grids and meters enable more efficient energy distribution and consumption. They allow utilities to monitor and manage energy flow in real-time, reducing losses during transmission and distribution. This can help India address its energy efficiency challenges and reduce energy wastage.
- **Renewable Energy Integration:** India has set an ambitious target of having 500 GW of installed renewable energy by 2030, which includes the installation of 280 GW of solar power and 140 GW of wind power. Smart grids can integrate renewable energy sources like solar and wind more effectively by managing fluctuations in supply and demand. This makes the grid more reliable and resilient.
- **Environmental Concerns:** With growing concerns about environmental pollution and climate change, there is an increased focus on reducing carbon emissions. Smart grids support the development of a more sustainable energy ecosystem.
- **Policy reforms:** Government schemes such as Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY), Integrated Power Development Scheme, NSGM etc. have boosted implementation of Smart Meter across the country.

iii. Challenges

Here are some of the key challenges for implementing smart grids and meters in India:

- **Data Security and Privacy:** Smart meters and grids collect a vast amount of data about energy consumption patterns. Ensuring the security and privacy of this data is critical to prevent unauthorized access and potential misuse.
- **Cybersecurity:** Smart grids and meters also pose significant cybersecurity risks, as they can be targeted by hackers, malicious insiders, or state actors to disrupt the power grid, steal sensitive information, or manipulate billing and pricing. Robust cybersecurity measures are necessary to protect these systems.

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- In October 2021, the Ministry of Power (MoP) and Central Authority of Electricity (CEA) has released the [guidelines for cybersecurity in the power sector](#) to be adhered by all Power Sector utilities to create cyber secure eco system.
- **High capital investment:** Substantial upfront investment is required for the deployment/implementation of smart grid infrastructure and the installation of smart meters. Many utilities in India face financial constraints, which can impede their ability to make these investments.
- **Lack of Interoperability Standards:** Ensuring that different components of smart grids and meters from various manufacturers can work seamlessly together is essential. Lack of interoperability standards can lead to compatibility issues and hinder the scalability of the technology.

iv. Standardization

Bureau of Indian Standards (BIS) has following technical committees which are developing standards in support of smart grid/meter:

- **ETD-13: Equipment for Electrical Energy Measurement and Load Control (Smart Meter):** ETD 13 is responsible for preparing standards for equipment for electrical energy measurement, tariff - and load control, customer information, payment, local and/or remote data exchange, using electromechanical and/or electronic, technologies for applications ranging from electrical energy generation to residential. The standards may include requirements and test methods to cover mechanical, environmental, electrical, safety, metrology dependability aspects as well as functional requirements and data models. It is mirror technical committee of IEC TC-13 (P): Electrical energy measurement and control.
 - ✓ [IS 15959 \(Part 2\): 2016](#): Data exchange for electricity meter reading tariff and load control - Companion specification Part 2 smart meter
 - ✓ [IS 15959 \(Part 3\): 2017](#): Data exchange for electricity meter reading tariff and load control - Companion specification Part 3 smart meter Transformer Operated KWh And KVarh Class 0 2 S 0 5 S And 1 0 S
 - ✓ [IS 16444: 2015](#): AC static direct connected watthour smart meter class 1 and 2 - Specification
 - ✓ [IS 16444 \(Part 2\): 2017](#): AC static transformer operated watthour and var - Hour smart meters class 0 2 S 0 5 S and 1 0 S Part 2 specification transformer operated smart meters.

For more information, please [click here>>](#)

- **ETD 46: Grid Integration:** ETD 46 is responsible for preparing standards in the field of Grid Integration comprising of LT (ON Grid, Off Grid and Hybrid with and without storage), HT and EHT for all capacities. For more information, please [click here>>](#)
- **ETD 50: LVDC Power Distribution Systems:** ETD 50 is responsible for preparing standards on: a) LVDC System Requirements, Safety, and Installation Guidelines b)

LVDC products including electrical wiring accessories and Applications c) Integration of DC Infrastructure d) Non-Traditional Distribution Networks/**Microgrids**. For more information, please [click here>>](#)

- **LITD 10: Power system Control and associated Communications:** To prepare Indian Standards relating to: a) Power system control equipment and systems including EMS (Energy Management System) b) DMS (Distribution Management System) c) SCADA (Supervisory Control and Data Acquisition) d) Distribution automation, Smart Grid, tele-protection, and associated communications used in planning, operation, and maintenance of power systems.
 - ✓ [IS/IEC 62488-1: 2012](#): Power line communication systems for power utility applications Part 1: Planning of analogue and digital power line carrier systems operating over EHVHVMV electricity grids.

For more information, please [click here>>](#)

3. Green and Clean Technologies

Green and clean technologies play a critical role in combatting climate change by reducing greenhouse gas emissions, promoting sustainability, and mitigating the environmental impact of human activities. Recognizing the importance of combatting climate change, India has set itself the target of becoming net-zero by 2070. Besides the overall goal for 2070, the country has also set the following targets for 2030:

- Meet 50% of energy requirements from renewable energy.
- Reach a non-fossil fuel capacity of 500GW.
- Reduce carbon emissions by 1 billion tons.
- Reduce carbon intensity by 45%.

In line with its commitment to reach 500 GW of non-fossil fuel energy capacity by 2030 and meet 50% of its energy requirements through renewable energy and non-fossil energy sources, Government of India has made impressive strides in the renewable energy sector, positioning itself as a frontrunner in the global renewable energy market. India's total renewable energy capacity, excluding large hydro and nuclear plants, reached over [125 gigawatts](#) in May 2023.

The remarkable growth of solar and wind energy capacity has cemented India's position as a global leader in renewable energy adoption. Today, **India stands 4th globally in Renewable Energy Installed Capacity**, with 43% of its total installed electricity capacity coming from non-fossil energy sources.

The government has played a proactive role in promoting the use of renewable energy sources. The flagship [National Solar Mission](#), launched in 2010, aimed to install 100 GW of solar power by 2022, which was later increased to 450 GW by 2030. The Centre has also launched a [wind energy program](#) with a target of achieving a capacity of 60 GW by 2022. These ambitious targets have been instrumental in promoting renewable energy adoption in the country.

Despite these success, Indian renewable energy sector still faces challenges such as grid integration and storage capacity. To address these challenges, the government has launched several initiatives aimed at improving grid infrastructure and storage capacity. The [Green Energy Corridor project](#), launched in 2013, aims to improve the transmission infrastructure for renewable energy and increase the capacity of grid-connected renewable energy. The government has also released a [detailed framework to reshape the nation's energy sector](#), with a particular focus on bolstering energy storage systems (ESS).

To combat climate change and promote environmentally conscious actions, the Indian government has introduced a grassroots initiative called "[LiFE](#)" ([Lifestyle for Environment](#)) during COP26 in Glasgow in October 2021. This global movement aims to inspire and mobilize communities worldwide towards a mindful and deliberate approach to utilization, steering away from mindless and destructive consumption, all for the noble cause of safeguarding and preserving our environment.

Following the introduction of LiFE, the Ministry of Environment, Forest and Climate Change, Government of India has issued [Green Credit Program \(GCP\)](#) and [Ecomark scheme](#) to Promote Sustainable Lifestyle and Environmental Conservation.

According to a report released by FICCI and Deloitte on September 25, 2023, India's energy transition will be expensive, and the country would require \$15 trillion to achieve net-zero between 2022 and 2070. The report estimates that the industrial sector will contribute 65-70 percent to the total energy demand. In the transport sector, passenger and freight demand is expected to increase by 3–5x by 2070. However, energy demand will remain moderate due to a high uptake of electric vehicles (EVs) with higher energy conversion efficiency²².

During the recently concluded "**G20 Summit 2023**" in New Delhi, India, the Group of 20 nations (G20) also committed to tripling the worldwide renewable energy capacity by 2030, cutting greenhouse gas (GHG) emissions by 43% by 2030, and reaching a 'net zero' emissions status by 2050.

3.1. Green Hydrogen

India has pledged to achieve its net-zero emissions goal by 2070 and become an energy independent nation by 2047 where green hydrogen will play an active role as an alternate fuel to petroleum/ fossil-based products. In 2020, India's hydrogen demand stood at 6 million tonnes (MT) per year. It is estimated that by 2030, the hydrogen costs will be down by 50%. According to **NITI Aayog** report titled "[Harnessing Green Hydrogen](#)" the demand for hydrogen is expected to see more than fourfold jump to 29 MT by 2050. Almost 94% of hydrogen demand in 2050 can be met by green hydrogen, up from 16% in 2030. The cumulative value of the green hydrogen market in India could be \$8 billion by 2030 and \$340 billion by 2050.

²² [India would require \\$15 trillion to achieve net-zero by 2070: FICCI-Deloitte report \(moneycontrol.com\)](#)

Addressing the nation on the 75th Independence Day on 15th August 2021, Prime Minister of India Narendra Modi announced the **National Hydrogen Mission** with an aim of making India a hub for the production and export of green hydrogen.

i. Key policy initiative

India has established following several policies and guidelines to promote green hydrogen and aid in the smooth implementation of the **National Hydrogen Mission**.

a) **National Green Hydrogen Mission 2023**

Ministry of New and Renewable Energy (MNRE), Government of India launched the National Green Hydrogen Mission on 4th January 2023. The overarching objective of the Mission is to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. This will contribute to India's aim to become Aatmanirbhar (self-reliant) through clean energy and serve as an inspiration for the global Clean Energy Transition. The Mission will lead to significant decarbonisation of the economy, reduced dependence on fossil fuel imports, and enable India to assume technology and market leadership in Green Hydrogen.

Expected outcomes of the mission by 2030:

- Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country
- Over INR 8 lakh crore (approx. €89 billion) in total investments
- Creation of over 6 lakh (0.6 million) jobs
- Cumulative reduction in fossil fuel imports over Rs. 1 lakh crore (€11 billion)
- Reduction of nearly 50 MMT of annual greenhouse gas emissions

The initial outlay for the Mission will be INR 19,744 crore (approx. €2.2 billion), including an outlay of INR 17,490 crore (approx. €1.9 billion) for the Strategic Interventions for Green Hydrogen Transition' (SIGHT) programme, INR 1,466 crore (€164 million) for pilot projects, INR 400 crore (approx. €44 million) for R&D, and INR 388 crore (approx. 43 million) towards other Mission components.

All concerned Ministries, Departments, agencies, and institutions of the Central and State Governments will undertake focussed and coordinated steps to ensure successful achievement of the Mission objectives. Ministry of New & Renewable Energy will be responsible for overall coordination and implementation of the Mission. [Read more/Download>>](#)

b) **Green Hydrogen Standard for India**

For further progress of the **National Green Hydrogen Mission**, in August 2023, the Ministry of New and Renewable Energy (MNRE) notified the '[Green Hydrogen Standard for India](#)', outlining the emission thresholds for production of hydrogen that can be classified as 'green'.

Government has specified following:

1. **Green Hydrogen** shall mean Hydrogen produced using renewable energy, including, but not limited to, production through electrolysis or conversion of biomass. Renewable energy also includes such electricity generated from renewable sources which is stored in an energy storage system or banked with the grid in accordance with applicable regulations.

Whereas, for Green Hydrogen produced through electrolysis: The non-biogenic greenhouse gas emissions arising from water treatment, electrolysis, gas purification and drying and compression of hydrogen shall not be greater than 2 kilogram of carbon dioxide equivalent per kilogram of Hydrogen (kg CO₂ eq/kg Hydrogen), taken as an average over last 12-month period.

Whereas, for Green Hydrogen produced through conversion of biomass: The non-biogenic greenhouse gas emissions arising from biomass processing, heat/steam generation, conversion of biomass to hydrogen, gas purification and drying and compression of hydrogen shall not be greater than 2 kilogram of carbon dioxide equivalent per kilogram of Hydrogen (kg CO₂ eq/kg Hydrogen) taken as an average over last 12-month period.

2. A detailed methodology for measurement, reporting, monitoring, onsite verification and certification of green hydrogen and its derivatives shall be specified by MNRE.
3. **Bureau of Energy Efficiency (BEE)** shall be the Nodal Authority for accreditation of agencies for the monitoring, verification, and certification for Green Hydrogen production projects.

c) [Green Hydrogen/Green Ammonia policy 2022](#)

Ministry of Power (MoP), Government of India notified "Green Hydrogen/ Green Ammonia Policy" in February 2022.

The policy provides as follows:

- i. Green Hydrogen / Ammonia manufacturers may purchase renewable power from the power exchange or set up renewable energy capacity themselves or through any other, developer, anywhere.
- ii. Open access will be granted within 15 days of receipt of application.
- iii. The Green Hydrogen / Ammonia manufacturer can bank his unconsumed renewable power, up to 30 days, with distribution company and take it back when required.
- iv. Distribution licensees can also procure and supply Renewable Energy to the manufacturers of Green Hydrogen / Green Ammonia in their States at concessional prices which will only include the cost of procurement, wheeling charges and a small margin as determined by the State Commission.
- v. Waiver of inter-state transmission charges for a period of 25 years will be allowed to the manufacturers of Green Hydrogen and Green Ammonia for the projects commissioned before 30th June 2025.

- vi. The manufacturers of Green Hydrogen / Ammonia and the renewable energy plant shall be given connectivity to the grid on priority basis to avoid any procedural delays.
- vii. The benefit of Renewable Purchase Obligation (RPO) will be granted incentive to the hydrogen/Ammonia manufacturer and the Distribution licensee for consumption of renewable power.
- viii. To ensure ease of doing business a single portal for carrying out all the activities including statutory clearances in a time bound manner will be set up by MNRE.
- ix. Connectivity, at the generation end and the Green Hydrogen / Green Ammonia manufacturing end, to the ISTS for Renewable Energy capacity set up for the purpose of manufacturing Green Hydrogen / Green Ammonia shall be granted on priority.
- x. Manufacturers of Green Hydrogen / Green Ammonia shall be allowed to set up bunkers near Ports for storage of Green Ammonia for export / use by shipping. The land for the storage for this purpose shall be provided by the respective Port Authorities at applicable charges.

The implementation of this Policy will provide clean fuel to the common people of the country. This will reduce dependence on fossil fuel and reduce crude oil imports. The objective also is for our country to emerge as an export Hub for Green Hydrogen and Green Ammonia.

The policy promotes Renewable Energy (RE) generation as RE will be the basic ingredient in making green hydrogen. This in turn will help in meeting the international commitments for clean energy. [Read more/Download>>](#)

d) R&D Roadmap for Green Hydrogen ecosystem in India

The Ministry of New and Renewable Energy (MNRE), on July 5, 2023, has unveiled a draft roadmap for Green Hydrogen ecosystem in India. The draft roadmap is outlining the research and development (R&D) priorities for manufacturing and storing green hydrogen.

The roadmap aims to promote efficient, safe, and cost-effective hydrogen storage, paving the way for its widespread adoption as a clean energy source.

The key objectives include:

- Steep reduction in electrolyser capital and operational expenditure.
- Enhance operational capacity and efficiency, keeping in mind durability and reliability, especially when operating dynamically.
- Decrease carbon footprint by increasing current density.
- Showcase the benefits of adding electrolysers to the power system through their ability to seamlessly integrate higher concentrations of renewables while providing flexibility.
- Reducing the life-cycle carbon footprint of electrolysers by ensuring circularity of material employed as well as for the production process.
- Design and develop large-scale (MW) Electrolyser systems, including Stack and BOP.
- Build capacity and keep stock of material and critical components of Electrolyser stacks.

- Deployment rates to be increased.
- Reengineer and improve manufacturing for both water and steam electrolysis.

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ii. Growth drivers

- **Climate Goals:** India's commitment to reducing greenhouse gas emissions and transitioning to a low-carbon economy under the Paris Agreement is a significant driver for exploring green hydrogen as a clean energy source.
- **Renewable Energy Potential:** India has abundant renewable energy resources, including solar and wind, which can be harnessed to produce green hydrogen through water electrolysis using renewable electricity.
- **Government Support:** The Indian government has recognized the potential of green hydrogen and has introduced policies and initiatives such as National Green Hydrogen Mission, Green Hydrogen Policy etc. to support its development.
- **International Collaborations:** India has also been actively engaging in international collaborations to promote green hydrogen. It has joined the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) and has signed agreements with countries like Australia and Japan to explore opportunities for collaboration in the hydrogen sector.

The recent G20 leaders' declaration agreed to support the acceleration of production, utilisation, and the development of transparent and resilient global markets for hydrogen produced from zero and low-emission technologies and its derivatives such as ammonia. Besides, the ambitious India-Middle East-Europe Economic Corridor envisages to transport of green hydrogen for trade as well. The government believes that embracing green hydrogen will help the nation reduce at least Rs 1 lakh crore worth of fossil fuel imports and nearly 50 million tonnes per annum of carbon dioxide emissions by 2030. India's clean fuel quest has already drawn corporate biggies such as Reliance, Adani, Tatas, NTPC, GAIL, IOC, and L&T into the green hydrogen space.

- **Decarbonizing Sectors:** Sectors such as industry, transportation, and power generation that are difficult to decarbonize directly can use green hydrogen as a clean alternative to fossil fuels.

iii. Challenges

- **High cost:** Currently, the production cost of green hydrogen from renewable energy is higher compared to hydrogen derived from fossil fuels. High production costs hinder widespread adoption. To reduce Green Hydrogen (GH₂) costs, India needs consistent and low-cost renewable energy.

- **Lack of investment and insufficient infrastructure:** Establishment of necessary infrastructure for producing, transporting, storing, and distributing green hydrogen requires significant investment.
- **Availability of water:** Green hydrogen production requires plenty of water, and India is already facing water scarcity in many regions. Therefore, the availability of water for green hydrogen production could be a significant challenge in India.
- **Lack of harmonised standards and regulations:** A robust ecosystem of harmonized standards and regulations is necessary to enable safe and rapid scaling up of projects for production, delivery, storage, and use of green hydrogen.

iv. Standardization

[India has notified its Green Hydrogen Standard](#) which limits carbon dioxide emissions to less than or equal to 2 kg. per kg. of hydrogen.” For more information, please [click here](#)

3.2. Circular Economy/Resource Efficiency

Due to rapid urbanization, economic growth and higher rates of urban consumption, India is among the world's top 10 countries generating municipal solid waste (MSW). According to a report by The Energy and Resources Institute (TERI), India generates over 62 million tons (MT) of waste in a year. Only 43 MT of total waste generated gets collected, with 12 MT being treated before disposal, and the remaining 31 MT simply discarded in wasteyards. Most of the waste generated remains untreated and even unaccounted for.

A study featured in the Journal of Urban Management (December 2021) reports that the 62 MT of waste generated annually includes 7.9 MT of hazardous waste, 5.6 MT of plastic waste, 1.5 MT of e-waste, and 0.17 MT of biomedical waste. The Indian Central Pollution Control Board (CPCB) recently projected that annual waste generation in India will increase to 165 MT by 2030. Hazardous, plastic, e-waste, and bio-medical waste generated is expected to increase proportionately, as well.

The need for India to adopt a circular economy model to reverse the environmental crisis has become increasingly pressing, given the country's rapidly expanding population, swift urbanisation, and escalating environmental pollution and climate change. A circular economy approach, which emphasises the need for an integrated view of processes and products, is essential for minimising resource dependency and gaining a competitive advantage. The adoption of such a model could yield substantial annual benefits and result in a significant reduction in congestion and pollution, which would have a multiplier effect on the economy.

India's circular economy could touch \$45 billion by 2030, an opportunity startups can potentially tap into, according to a report by venture capital fund Kalaari Capital. Adopting circular economy practices can help generate savings of over \$624 billion by 2050 across sectors such as food, agriculture, construction, and mobility in India, the report said. Sectors such as fashion, construction, agriculture and food, mobility, and

rare earth materials are expected to provide the biggest opportunities for circular economy startups²³.

To expedite the transition of the country from a linear to a circular economy, Government of India has formed 11 committees—to be led by the concerned line ministries and comprising officials from MoEFCC and NITI Aayog, domain experts, academics, and industry representatives—for 11 focus areas (table 1). The committees will prepare comprehensive action plans for transitioning from a linear to a circular economy in their respective focus areas. They will also carry out the necessary modalities to ensure the effective implementation of their findings and recommendations.

The focus areas include 11 end-of-life products/recyclable materials/wastes that either continue to pose considerable challenges or are emerging as new challenge areas that must be addressed in a holistic manner.

Table:1

S. No.	Focus Area	Concerned Line Ministry
1	Municipal Solid Waste and Liquid Waste	Ministry of Housing and Urban Affairs
2	Scrap Metal (Ferrous and Non-Ferrous)	Ministry of Steel
3	Electronic Waste	Ministry of Electronics and Information Technology
4	Lithium Ion (Li-ion) Batteries	NITI Aayog
5	Solar Panels	MNRE
6.	Gypsum	Department for Promotion of Industry and Internal Trade
7	Toxic and Hazardous Industrial Waste	Department of Chemicals and Petrochemicals
8	Used Oil Waste	Ministry of Petroleum and Natural Gas
9	Agriculture Waste	Ministry of Agriculture and Farmers' Welfare
10	Tyre and Rubber Recycling	Department for Promotion of Industry and Internal Trade
11	End-of-life Vehicles (ELVs)	Ministry of Road Transport and Highways

The Government has been actively formulating policies and promoting projects to drive the country towards a circular economy/Resource efficiency. It has already notified

²³ <https://www.livemint.com/news/india/circular-economy-a-45-billion-opportunity-by-2030-in-india-report-11650628743418.html>

various rules, such as the [Plastic Waste Management Rules](#), [e-Waste Management Rules](#), [Construction and Demolition Waste Management Rules](#), [Battery Waste Management Rules 2022](#), [Solid Waste Management Rules, 2016](#), [Metals Recycling Policy](#) etc., in this regard. The Rules are geared towards reducing waste generation and maximizing recycling of waste.

In this section, some of the key policies and initiatives implemented by the Indian government to promote the circular economy and Resource Efficiency are being explored.

i. Key policy initiatives

a) Draft National Resource Efficiency Policy, 2019

The Ministry of Environment, Forests and Climate Change has proposed a draft **National Resource Efficiency Policy 2019**. It aims to streamline the efficient use of these resources with minimum negative impact on environment.

Key features of the policy:

- ✓ It seeks to set up a **National Resource Efficiency Authority (NREA)** with a core working group housed in the Ministry of Environment, Forest and Climate Change and a members group with representations from different ministries, state/union territory, and other stakeholders.
- ✓ The authority would be supported by an **Inter-Ministerial National Resource Efficiency Board** to guide on the aspects critical to its implementation.
- ✓ It also plans to **offer tax benefits** on recycled materials, green loans to small and medium Enterprises (SMEs) and soft loans to construct waste disposal facilities, apart from setting up **Material Recovery Facilities (MRF)**.
- ✓ Manufacturers and service providers would also be required to use more recycled or renewable materials and awareness would be created among consumers to indicate the shift.
- ✓ Idea of the national policy is to drive the country towards **circular economy** through efficient use of available material resources, based on principle of 6R and 'green public procurement'.
- ✓ **The 6R stands for reduce, reuse, recycle, redesign, re-manufacture and refurbish** while the very premise of 'green public procurement' is to procure products with lower environmental footprints such as secondary raw materials and locally sourced materials.
- ✓ It also pitches for moving towards '**zero landfill**' approach in the country, hinting at possibility of imposing 'landfill taxes' and 'high tipping fees' for bulk generators of waste so that they can move towards optimal use of materials and better waste management.

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b) Strategy paper on Resource Efficiency: NITI Aayog

In November, 2017, NITI Aayog along with EU Delegation to India had prepared a [Strategy paper on Resource Efficiency](#). The objective of the RE Strategy is to make recommendations for enhancing the resource-use efficiency in the Indian economy and

industry, develop indicators for monitoring progress, and create an ecosystem for improving the resource security and minimising environmental impacts.

Following up on this strategy paper, in January 2019, a status paper titled "[Resource Efficiency & Circular Economy – Current status and Way forward](#)" has also been prepared with four focus areas namely steel, aluminium, E-waste and Construction and Demolition waste. This status paper is based on findings from sectoral strategy papers on [steel](#), [aluminium](#), E-waste and [Construction and Demolition waste](#) prepared by concerned ministries/departments in association with NITI Aayog and other key stakeholders including EU delegation to India. [Read more/Download>>](#)

c) Draft policy paper on Circular Economy in Electronics and Electrical Sector: Meity

In May ,2021, the Ministry of Electronics and Information Technology has floated a policy paper that intends to replace the current linear system of 'take-make-dispose' in the electrical and electronics manufacturing sector with a circular economy one. The paper titled "[Circular Economy in Electronics and Electrical Sector](#)," focuses on the life cycle of electronics – including stages of raw material acquisition, design, manufacturing/production stage, consumption to end of life (e-waste) management, and secondary raw materials utilization, among other issues.

The paper covers the entire lifecycle of the products used in EEE manufacturing, and makes short-, medium- and long-term suggestions about CE.

For example, in raw material procurement, it recommends mandatory use of a certain percentage of critical materials sources from secondary materials, the medium to long term, and promotion of technology for extraction of maximum number of materials through technology development/transfer, innovative finance mechanisms and schemes.

In the consumption stage, the policy recommendations include resource efficiency or circular economy labelling, eco-labelling on the products in the percentage use of recycled materials in the product to create consumer awareness in recycling aspects of products.

It further recommends regulation to increase EEE warranty from 2 to 6 years, measures against planned obsolescence, legal warranty of second-hand products and promoting green public procurement (GPP) by government agencies. [Read more>>](#)

d) Circular Economy Cell- NITI Aayog

Circular Economy Cell (CE Cell) was constituted in NITI Aayog in September 2022 as a dedicated unit to work around Circular Economy. 10 sectoral Circular Economy action plans were finalized in NITI Aayog for implementation by stakeholder Ministries/Departments. The primary activities encompass coordinating among stakeholder Ministries/Departments in implementing the Circular Economy action plans. Among other initiatives, CE Cell worked in coordination with MoRTH to operationalize the Vehicle Scrapping programme and developing a strategy for scrapping the fleet of unfit and old Central & State Government Vehicles. The envisioned activities for the upcoming financial year comprise preparation of a comprehensive Mission Document for Circular Economy, development of an interactive Dashboard elaborating the progress in different domains of Circular Economy and furthering engagement with States. [Read more](#)

ii. Growth Drivers

- **Resource Scarcity:** India's growing population and economy have put pressure on natural resources. The circular economy offers a way to reduce resource depletion by maximizing the use of existing resources.
- **Environmental Concerns:** Increasing awareness of environmental degradation, pollution, and waste management issues has led to a greater focus on sustainable practices like circular economy principles.
- **Consumer Awareness:** As consumers become more environmentally conscious, there's an increasing demand for sustainable products and services, which can drive adoption of circular economy practices.
- **Economic Opportunities:** The Circular Economy can create new business models, jobs, and economic growth by promoting recycling, remanufacturing, and value-added services.
- **Government Support:** Government policies, such as extended producer responsibility (EPR) regulations and waste management rules, drive businesses to adopt circular practices and reduce waste.

iii. Challenges

The implementation of a circular economy in India faces several challenges. Some of the key challenges include:

- **Lack of awareness and understanding of circular economy concepts among businesses and consumers:** The government needs to create awareness campaigns and education programs to promote the adoption of circular economy practices and encourage consumers to adopt sustainable consumption patterns.
- **Inadequate waste collection and segregation:** India generates a vast amount of waste every day, and a large proportion of it is not adequately collected or segregated, leading to environmental and health hazards. India needs to improve waste collection and segregation systems to enable the efficient and effective processing of waste.
- **Lack of infrastructure and recycling technologies:** India's infrastructure is not well-suited to support a circular economy. For example, there is a lack of recycling facilities, which makes it difficult to recycle and reuse materials. This would require significant public and private sector investment in setting up recycling facilities and developing and deploying recycling technologies.
- **Lack of support and incentives from Government:** Industries are reluctant in adopting the circular economy model due to lack of government support and incentives to invest in waste collection, reusing/ recycling/re-manufacturing processes and setting up recycling facilities. The high cost of effective waste treatment and remanufacturing for industries also impedes their efforts in this area.

- **Lack of research and development in adopting Circular Economy:** The transition to a circular economy requires a fundamental shift in the way we design, produce, consume, and dispose of goods and services. This shift requires innovation and new approaches to address the challenges of resource depletion, waste, and environmental degradation. However, the lack of research and development in this field can limit the knowledge and expertise needed to develop circular business models, technologies, and products. Without R&D, businesses may not have the resources to develop and implement innovative circular solutions²⁴.

iv. Standardization

In recent years, Bureau of Indian Standards (BIS) has developed standards for recycled products that can be used to promote resource efficiency in the economy.

- **PCD 12: Plastics:** To formulate Indian Standards for specifications for thermosetting and thermoplastic resins-bonded and moulding materials; natural and synthetic polymers, synthetic resin bonded laminates thermoplastic films and sheets, plasticizers cellular plastics, finished plastic articles, composites and reinforced plastics (excluding sanitary wares and plastic pipes for water supply and plastic packaging containers) safety of toys, and natural and synthetic adhesives (excluding for plywood industry and electrical tapes).
 - ✓ **IS 14534: 2023:** Plastics guidelines for the recovery and recycling of plastics waste.
 - ✓ **IS 14535: 1998:** Recycled plastics for the manufacturing of products – Designation.

For more information please [click here](#)

- **CHD 32: Environment Protection:** To formulate Indian Standards on i) Terminology, methods of sampling and characterization of soil (excluding engineering and agricultural purposes) ii) Codes of Practices and Guidelines on reduction, recycling, reuse, treatment, and disposal of wastes (other than solid wastes); iii) Characterization and classification of wastes (other than solid wastes), iv) Guidelines and Codes of Practices for control of pollution. For more information please [click here>>](#)
- **CHD 33: Solid Waste Management:** To formulate Indian Standards on i) Specifications, Terminology, methods of sampling and characterization of solid waste (Excluding Bio- Medical & Nuclear Waste), ii) Codes of Practices on reduction, recycling, reuse, and treatment of Solid wastes (Excluding Bio-Medical & Nuclear Waste), iii) Guidelines and codes of practice for Solid waste disposal (Excluding Bio-Medical & Nuclear Waste).
 - ✓ [IS 12647: 2021](#): SOLID WASTE MANAGEMENT COLLECTION EQUIPMENT REQUIREMENTS AND GUIDELINES
 - ✓ [IS 12662 \(Part 1\): 2021](#): GUIDELINES FOR USE OF VEHICLES FOR COLLECTION AND TRANSPORTATION OF SOLID WASTES PART 1 SELECTION OF VEHICLES

²⁴ <https://eacpm.gov.in/wp-content/uploads/2023/07/17-Indias-Tryst-with-a-Circular-Economy.pdf>

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- ✓ [IS 16557: 2016](#): Solid waste management - Segregation, collection, and utilization at household/community level – Guidelines
- ✓ [IS 17862: 2022](#): STORAGE COLLECTION DISMANTLING AND RECYCLING OF E-WASTE GUIDELINES

For more information, please [click here>>](#)

- **CHD34: Environmental Management:** To formulate Indian Standards in the field of Environment Management tools and systems including: - Life Cycle Assessment - GHG management - climate change and adaptation - Environmental labelling - Circular Economy but excluding: - test methods of pollutant - setting limit values regarding pollutants of effluents - setting environmental performance levels - standardization of products.
 - ✓ [IS 17022: 2018](#): Guidelines for green manufacturing practices.

For more information, please [click here>>](#)

- **ETD 43: Standardization of Environmental Aspects for Electrical and Electronic Products:** To prepare the necessary guidelines, basic standards, in the environmental area, in close cooperation with product committees, which remain autonomous in dealing with the environmental aspects relevant to their products; To liaise with product committees in the elaboration of environmental requirements of product standards in order to foster common technical approaches and solutions for similar problems and thus assure consistency in standards.
 - ✓ [IS 16584: 2017 IEC/TR 62635: 2012](#) Guidelines for End-of-Life Information Provided by Manufacturers and Recyclers and for Recyclable and for Recyclability Rate Calculation of Electrical and Electronic Equipment

For more information, please [click here>>](#)

BIS and the Indian Roads Congress have also come up with standards prescribing limits up to which recycled aggregates can be safely used in different applications. In 2016, BIS amended the **IS 383** standard to allow for the use of recycled aggregates from construction and demolition waste in concrete production (BIS, 2016). The Indian Roads Congress (IRC) has issued '[IRC-121:2017 Guidelines for Use of C&D Waste in Road Sector](#)' outlining what kind of materials from recycled C&D waste and in what proportion, may be safely used for specific road construction/repair applications.

3.3. Electric Vehicle

The automotive industry in India is expected to play a critical role in the transition towards green energy. The government of India is actively promoting the adoption of electric vehicles (EVs) and targeting a 30% penetration rate by 2030. As per [industry estimates](#), the total EV sales in India stood at around 10 lakh (1 million) units in 2022. According to [Economic survey 2022-23](#), the domestic electric vehicles (EV) market is expected to grow at a compound annual growth rate (CAGR) of 49% between 2022 and 2030 and is expected to hit one crore (10 million) units of annual sales by 2030.

According to a [report](#) by NITI Aayog, India can save 64% of anticipated road based mobility related energy demand and 37% of carbon emissions in 2030 by pursuing a shared, electric and connected mobility resulting in a net savings of roughly Rs 3.9 lakh crore (approximately €43.33 billion) in 2030.

Several schemes and incentives such as NEMMP 2020, FAME Scheme, PLI SCHEME, and Battery Swapping Policy, Tax Reduction on EVs etc. have been launched by the government to boost the demand for electric vehicles as well as motivate manufacturers to invest in the R&D of electric vehicles and related infrastructure.

i. Key policy initiatives

Following are the government Policies and incentives for electric vehicles in India.

a) National Electric Mobility Mission Plan

Government of India launched the National Electric Mobility Mission Plan (NEMMP) in year 2013. NEMMP is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in the country. This plan has been designed to enhance national fuel security, to provide affordable and environmentally friendly transportation and to enable the Indian automotive industry to achieve global manufacturing leadership.

As part of the [National Electric Mobility Mission](#), Department of Heavy Industry formulated a Scheme viz. **Faster Adoption and Manufacturing of (Hybrid & Electric Vehicles in India (FAME India) Scheme** in the year 2015 to encourage electric and hybrid vehicle purchase by providing financial support and also by way of establishing a necessary charging Infrastructure for electric vehicles. Its first phase ran for four years until 2019. The second phase (FAME II) commenced on April 1, 2019, for a period of three years, which was further extended for a period of two years up to March 31, 2024.

Under FAME II, the Ministry of Heavy Industry has also announced a phased manufacturing program for subsidy eligibility for EV public charging stations and related equipment including input and output switchgears, charging guns and power modules, among others. For more information about FAME scheme, please [click here>>](#)

b) Technology platform for Electric Mobility

Technology Platform for Electric Mobility (TPEM) is creating a collaborative platform for developers, suppliers, automakers to work together in five areas – lithium battery technology, motors and drives, charging infrastructure, drive cycle and traffic pattern, light-weighting of XEVs – and developing affordable electric technology, which will be open for use by all in manufacturing two-wheelers, three-wheelers and commercial vehicles used for public transport. [Read more \(https://dhi.nic.in/UserView/index?mid=2428\)](https://dhi.nic.in/UserView/index?mid=2428)

c) Guidelines and standards for Charging infrastructure for EVs

The “Charging Infrastructure for Electric Vehicle – Guidelines and Standards” were issued by Ministry of Power in Dec 2018 which were subsequently revised in October 2019, June 2020 and most recently in January 2022.

The objectives of the guidelines are as below:

- to enable faster adoption of EVs in India by ensuring safe, reliable, accessible, and affordable charging infrastructure and ecosystem.

- to provide affordable tariffs for charging station operators/owners and EV owners and proactively support the creation of EV charging infrastructure.
- to promote energy security and reduce the emission intensity in the country.
- To encourage preparedness of Electrical Distribution System to adopt EV charging infrastructure.

The document also spells out specifics such as definitions, compliance requirements for public charging infrastructure builders, tariff rules for supply of electricity to charging stations, provision of land at promotional rates for public charging, phase, and priority-wise identification of locations for coverage and implementation mechanism. [Read more/Download guidelines and standards for charging infrastructure>>](#)

d) National Mission on Transformative mobility and Battery storage

The Union Cabinet chaired by Hon'ble Prime Minister Narendra Modi approved setting up of a National Mission on Transformative Mobility and Battery Storage, to drive clean, connected, shared, sustainable and holistic mobility initiatives.

The Mission will develop strategies for transformative mobility and Phased Manufacturing Programme (PMP) for EVs, EV components and batteries. PMP will focus on Battery, raw materials, electrochemistry, end of life treatment, cell manufacturing, modules, battery packs. PMP would support setting up of large-scale, export-competitive integrated batteries and cell-manufacturing Giga plants in India, as well as localize production across the entire EV value chain. The Mission's objective is to coordinate with relevant Central Ministries/ Departments and States in integrating various initiatives for mobility transformation in India. [Read more](#)

e) Draft Battery swapping policy 2022

In April 2022, NITI Aayog, public policy think tank of Government of India released draft "BATTERY SWAPPING POLICY" to catalyse the large-scale adoption of EVs by improving efficient and effective use of scarce resources (viz. public funds, land, and raw materials for advanced cell batteries) for the delivery of customer centric services.

The draft policy aims to promote swapping of batteries with Advanced Chemistry Cell (ACC) batteries to decouple battery costs from the upfront purchasing costs of EVs. It aims to create unique battery codes for ACC batteries falling under this policy. [Read more about draft battery swapping policy>>](#)

f) Tax reduction on EVs

Government of India has reduced Goods and Services Tax (GST) on EVs from 12% to 5%; GST on chargers/ charging stations for EVs has been reduced from 18% to 5%.

g) Production Linked Incentive (PLI) Scheme

- **Production Linked Incentive (PLI) Scheme for Automotive Sector:** The Government on 15th Sep 2021 approved the PLI Scheme for Automotive Sector with a budgetary outlay of INR 25,938 crores (approx. €2.88 billion) to support domestic manufacturing of vehicles. Electric vehicles are covered under this PLI scheme.
- **PLI Scheme for Advanced Chemistry Cell (ACC):** The Government on 12th May 2021 approved PLI Scheme for manufacturing of ACC in the country with a budgetary outlay of INR 18,100 crore (approx. €2 billion). The scheme envisages

establishing a competitive ACC battery manufacturing set up in the country for 50 GWh. Additionally, 5GWh of niche ACC technologies is also covered under the Scheme.

ii. Growth Drivers

- **Growing Demand:** The demand for EVs in India has increased due to the newer generation being more environmentally conscious and a sharp increase in petrol and diesel prices. Due to the gap in the market for suitable replacements for conventional vehicles, this is the time for domestic manufacturers to increase their share of market acquisition.
- **Government Support:** There has been substantial investment in charging infrastructure across the country, along with many subsidies offered to new buyers and reduced road tax to consumers who buy EVs. A notable incentive scheme is the FAME scheme which has a budget outlay of 10,000 crores (approx. €1.1 billion) and is working towards a significant demand boost for EVs. The country's commitment to reducing carbon emissions and combating climate change has also been a driving force behind the rapid adoption of EVs, hence, it has created a conducive environment for the growth of the EV sector by offering various policies.
- **Low-Cost Manufacturing:** India is one of the largest manufacturers in the world and can produce low-cost, good quality Electric vehicles using its substantial manufacturing process.

India has been able to manufacture at a low cost due to its easy access to natural resources, which are essential for EV production. The vast pool of skilled and unskilled labour makes India a manufacturing haven.

These advantages have tempered many multinational corporations to establish a base in India. India can take over the EV manufacturing sector by a large margin by producing EVs and their parts at significantly lower prices. With an economy of scale coming in as a factor, EV prices can be slashed even more.

- **Decreasing battery costs:** The decreasing cost of batteries is a significant factor fuelling the growth of the electric vehicle market in India. The high cost of batteries has traditionally been a barrier to EV adoption, as it constitutes a substantial portion of the vehicle's total cost. However, advancements in technology and increased production have led to a rapid decrease in battery costs. With further advancements in battery technology and economies of scale in EV production, it is expected that the cost of EVs will decrease significantly in the coming years, making them more affordable and accessible to a wider range of consumers in India²⁵.

iii. Challenges

²⁵ <https://www.manufacturingtodayindia.com/sectors/heres-why-indias-electric-vehicle-market-to-double-in-2027>

It is not to say that it will be a smooth ride. There are various issues that India must work upon, to successfully meet its goal of having 30% electric vehicle fleet on road by 2030. These include the following:

- **Limited charging Infrastructure:** In India, the charging infrastructure is still relatively inadequate, particularly in non-metro cities and rural areas. The lack of proper electric vehicle charging infrastructure poses one of the greatest obstacles for adoption of electric vehicles in the country. Currently, the country has installed 8,738 operational public electric vehicle charging stations, as of June 30, 2023, according to the Bureau of Energy Efficiency (BEE) and the Ministry of Power data²⁶.
- **Shortage of Battery Raw Material:** India falls extremely behind in the lithium and cobalt reserves. It needs to speed up in securing lithium and cobalt. Cobalt's reserve is extremely low, limited only in Nagaland, Jharkhand, and Odisha.
- **Long charging time:** Just like conventional vehicles rely on petrol pumps or gas stations for refuelling, the mass adoption of electric vehicles mandates a robust charging infrastructure. the charging process of EVs can take anywhere from 30 minutes (in case of fast charging) up to 24 hours, depending on the capacity of the battery and motors. Most, however, take around four to six hours to be fully charged, which is several times longer than the time it takes to refuel a petrol/diesel car.
- **Lack of Consumer awareness and price sensitivity:** One of the key challenges faced by the EV globally is the lack of consumer awareness about EVs. Traditionally, the Indian consumer is extremely price sensitive and would be hesitant to invest in environmentally friendly products that are too expensive. Unless the battery and other electro-mobility parts are economically at par with the established ICE engine market, it is difficult for EVs to make a dent in the Indian market. EVs are expensive primarily due to their costly batteries which are mostly imported.
- **Lack of Standardization and interoperability:** The lack of standardization and interoperability between different charging networks also poses challenges for EV owners. The government, in collaboration with EV ecosystem players and auto OEMs, should prioritize establishing standardization protocols, ensuring interoperability, and promoting the development of fast-charging technologies.

iv. Standardization

Bureau of Indian Standards (BIS):

Within BIS the following two technical committees are responsible for developing standards related to Electric vehicle safety and charging infrastructure.

- **[TED 27 on Electric and Hybrid Vehicles](#)** is responsible for standardization of Electric and Hybrid vehicles and their components. It is national mirror technical committee of ISO/ TC 22/SC 37 and IEC/ TC 69. Please [click here](#) for the list of standards developed by TED 27.

²⁶ <https://government.economictimes.indiatimes.com/news/technology/8738-public-charging-stations-for-electric-vehicles-operational-in-the-country/102028327>

Enabling Europe-India Cooperation on Standards

- ✓ [IS 17855: 2022/ISO 12405-4:2018](#): Electrically propelled road vehicles - Test specification for lithium-ion traction battery packs and systems - Part 4: Performance testing.
 - [ETD 51 on Electrotechnology in mobility](#) is responsible for standardization of electrotechnical aspects of totally or partly electrically propelled road vehicles.
 - ✓ [IS/ISO 15118-1: 2013](#): Road vehicles - Vehicle to grid communication interface: Part 1 general information and use - Case definition.
 - ✓ [IS 17017 \(Part 1\): 2018](#): Electric Vehicle Conductive Charging System Part 1 General Requirements
 - ✓ [IS 17017 \(Part 23\): 2021](#): Electric Vehicle Conductive Charging Systems Part 23 dc Electric Vehicle Supply Equipment
 - ✓ [IS 17896 \(Part 1\): 2022/IEC TS 62840-1:2016](#): Electric vehicle battery swap system - Part 1: General and Guidance
 - ✓ [IS 17896 \(Part 2\): 2022/IEC 62840-2:2016](#): Electric vehicle battery swap system - Part 2: Safety requirements.
- [Click here](#) for the list of standards published by ETD 51.

For more information about BIS standards for Electric vehicle charging, please visit <https://e-amrit.niti.gov.in/bis-standard>

Automotive Research Association of India (ARAI):

ARAI, the leading [automotive Research and Development organization](#) of India, is one of the prime Testing and Certification agencies notified by the Government of India under Rule 126 of Central Motor Vehicle Rules, 1989. ARAI has set some Standards for Electric Vehicles & Chargers which are as follows:

- ✓ **AIS-138 Part1, Part2 / IS 17017** standard applies for charging infrastructure.
- ✓ **AIS-038 – Electric Power Train Vehicles-Construction and Functional Safety Requirements:** It includes requirements of a vehicle with regards to specific requirements for the electric power train and requirements of a vehicle Rechargeable Electrical Energy Storage System concerning its safety.
- ✓ **AIS-039 – Electric Power Train Vehicles–Measurement of Electrical Energy Consumption:** It helps in measuring the consumption of electric energy by electric vehicles.
- ✓ **AIS-040 – Electric Power Train Vehicles – Method of Measuring the Range:** It is a range test for the electric vehicles.
- ✓ **AIS-041 – Electric Power Train Vehicles – Measurement of Net Power and The Maximum 30 Minute Power:** It helps in the measurement of the net power of the electric vehicle and explains the working and benefits of the maximum 30-minute power.
- ✓ **AIS-049 – Electric Power Train Vehicles – CMVR Type Approval for Electric Power Train Vehicles:** It is a test of grade-ability for electric vehicles.
- ✓ **AIS-131** type-approval procedure for electric and hybrid electric vehicles introduced in the market for pilot/demonstration projects intended for a government scheme.
- ✓ **AIS-123** on CMVR Type Approval of Hybrid Electric System Intended for Retrofitment.
- ✓ **AIS-102 (Part 1 & 2)** on CMVR Type Approval for Hybrid Electric Vehicles²⁷.

For more information, please visit <https://www.araiindia.com/downloads>

²⁷ <https://e-vehicleinfo.com/electric-vehicles-in-india-arai-standards-and-regulation/>

3.4. Energy Storage Systems (ESS)

In a bid to meet the surging energy demands and integrate renewable energy sources effectively, India needs to bolster its energy storage infrastructure significantly. Use of energy storage systems by residential, commercial, or industrial consumers, in conjunction with renewable energy has potential to improve power quality and reliability for such consumers. This would also allow for minimization of diesel consumption from back-up power applications.

According to the [National Electricity Plan \(NEP\) 2023](#), the Central Electricity Authority (CEA) has projected a requirement of 74 gigawatts (GW) and 411 gigawatt-hours (GWh) of energy storage capacity by 2032. As per NEP 2023, the energy storage capacity requirements are set to escalate over the coming years. By 2026-27, India aims to have 16.13 GW of energy storage capacity, comprising 7.45 GW of Pumped Storage Plants (PSP) and 8.68 GW of Battery Energy Storage Systems (BESS), with a combined storage capacity of 82.32 GWh. This capacity will increase to 60.63 GW (18.98 GW PSP and 41.65 GW BESS) with a storage capacity of 336.4 GWh by 2029-30²⁸.

To ensure that India meets its BESS targets, government has approved **viability gap funding (VGF) to cover up to 40% of the total capital cost for the establishment of a 4,000 MWh battery energy storage system (BESS) in the country.**

i. Key policy initiatives

The government of India has taken various steps to speed up the development and adoption of energy storage systems in India.

a) National Energy Storage Mission (NESM)

To keep pace with the changing dynamics of the energy markets, India is now working toward a National Energy Storage Mission (NESM). In February 2018, a committee with representatives from relevant ministries, industry associations, research institutions and experts, was constituted by the MNRE to propose a draft for setting up NESM in India. The Expert Committee referred has proposed a draft NESM with objective to strive for leadership in energy storage sector by creating an enabling policy and regulatory framework that encourages manufacturing, deployment, innovation, and further cost reduction.

NITI Aayog and Rocky Mountain Institute's joint report on India's Energy Storage Mission has proposed three stage solution approach i.e. creating an environment for battery manufacturing growth; scaling supply chain strategies; and scaling of battery cell manufacturing.

The report is available [here>>](#)

²⁸ <https://energy.economictimes.indiatimes.com/news/power/india-would-need-74-gw-energy-storage-capacity-for-re-integration-by-2032-says-cea/103486822>

b) National Framework for promoting Energy Storage Systems

In August 2023, the Ministry of Power (MoP) has released comprehensive guidelines aimed at promoting energy storage adoption in India.

Objectives of the ESS framework:

- a) To have 24×7 dispatchable RE power i.e., RE-RTC (Renewable Energy- Round the Clock)
- b) To reduce greenhouse gas emissions and reduce overall costs of energy by incentivizing the deployment of ESS and reducing the need for fossil fuel power plants.
- c) To support the development and deployment of ESS through policy and regulatory measures, financial and fiscal incentives, and performance-based incentives.
- d) To redesign energy markets to incentivize participation of ESS in the markets and to establish market mechanisms through introduction of products, and compensation methods for storage services.
- e) To improve grid stability and reliability through deployment of ESS that provides grid services such as frequency regulation, voltage support, ramping, and other ancillary support services.
- f) To promote energy independence and resiliency through deployment of ESS in remote or islanded communities.
- g) To foster innovation and research for improving the performance, safety, and cost effectiveness of energy storage technologies and development of new energy storage technologies.
- h) To develop technical standards for ESS to ensure safety, reliability, and interoperability with the grid.
- i) To promote equitable access to energy storage by all segments of the population regardless of income, location, or other factors.
- j) To monitor and evaluate the performance and impact of ESS, and to provide feedback for making policy and investment decisions.

For more information please [click here>>](#)

c) Guidelines for Procurement and Utilization of Battery Energy Storage Systems

In March 2022, Ministry of Power issued detailed guidelines for procurement and utilization of BESS as part of generation, transmission, or distribution assets, or along with ancillary services. These guidelines, inter alia, provide standardization and uniformity in procurement of BESS and a risk-sharing framework between various stakeholders, involved in the energy storage and storage capacity procurement, thereby encouraging competition and enhanced bankability of these Projects.

These guidelines would ensure transparency and fairness in procurement processes and provide for a framework for an Intermediary Procurer as an Aggregator/Trading licensees/ Implementing Agency for the inter-state/intra-state sale-purchase of power.

For more information, please [click here>>](#)

d) National Programme on ACC Battery Storage

The Ministry of Heavy Industries (MHI), Govt. of India notified the [Production Linked Incentive \(PLI\) scheme, 'National Programme on Advanced Chemistry Cell \(ACC\) Battery Storage'](#) in 2021 for implementation of giga-watthour scale ACC manufacturing facilities in India with a budgetary outlay of INR 18,100 crore (approx. €2.19 billion).

The scheme envisaged the setting up a cumulative ACC manufacturing capacity of 50 GWh and an additional cumulative capacity of 5 GWh for Niche ACC Technologies. The incentive structure is designed to encourage the industry to promote fresh investments in indigenous supply chains and deep localization for ACC battery manufacturing in the country. For more information, please [click here>>](#)

ii. Growth Drivers

- **Renewable Energy Integration:** India is rapidly expanding its renewable energy portfolio, primarily through solar and wind power. Energy storage systems are essential for managing the intermittent nature of these sources, ensuring a stable and reliable power supply.
- **Grid Stability:** Energy storage systems contribute to grid stability by providing ancillary services such as frequency regulation and voltage control. In a country like India with an evolving grid infrastructure, these services are crucial for maintaining a reliable electricity supply.
- **Increasing adoption of Electric Vehicle (EV):** The growth of the electric vehicle market in India is driving demand for energy storage solutions, particularly in the form of lithium-ion batteries. These batteries are used not only in EVs but also for grid applications and residential storage.

iii. Challenges

- **High Initial Capital Costs:** The upfront costs of energy storage systems, particularly advanced technologies like lithium-ion batteries, are high. This makes it challenging for many consumers, businesses, and utilities to invest in energy storage infrastructure.
- **Inadequacy of raw materials:** Scarcity of the critical elements required to make batteries like lithium, copper, cobalt, and nickel.
- **Grid Integration Challenges:** Integrating energy storage systems into the existing grid infrastructure can be complex. Issues related to grid compatibility, standardization, and seamless operation need to be addressed for widespread deployment.
- **Lack of Regulations:** Regulatory frameworks for energy storage in India are still evolving. Uncertainty in regulations regarding tariffs, grid interconnection, and safety standards can deter potential investors and slow down adoption.
- **Financing and Access to Capital:** Access to financing and capital is a challenge for many stakeholders, including startups and small-scale projects. Innovative financing mechanisms and incentives are needed to make energy storage projects financially

viable. To address this challenge, Indian government has recently approved Rs. 3,760 crore (approx. €417 million) Viability Gap Funding (VGF) for creating battery energy storage system.

iv. Standardization

Bureau of Indian Standards (BIS) through its technical committee "ETD 52 on **Electrical Energy Storage System**" is responsible for: 1) Standardization in the field of grid integrated Electrical Energy Storage Systems. a) The Sectional Committee to focus on system aspects on EES Systems rather than energy storage devices and shall prepare Indian Standards dealing with the system aspects of electrical energy storage. 2) EES to include any type of grid-connected energy storages, which can both store electrical energy from a grid or any other source and provide electrical energy to a grid. a) The Sectional Committee to include Chemical ES as one of the ESS. b) Thermal storage to be included in the scope, only from the electricity exchange point of view. c) Unidirectional energy storages such as UPS not to be included in the scope of the sectional Committee.

4. Glossary

S. No.	Acronym	Expansion
1	3GPP	3rd Generation Partnership Project
2	ACC	Advanced Chemistry Cell
3	AI	Artificial Intelligence
4	AR	Augmented Reality
5	ARAI	Automotive Research Association of India
6	B6GA	Bharat 6G Alliance
7	BEE	Bureau of Energy Efficiency
8	CA	Certifying Authority
9	CAGR	Compound Annual Growth Rate
10	CCSP	C-DOT Common Service Platform
11	C-DoT	Centre For Development Of Telematics
12	CE	Circular Economy
13	CERT-In	Indian Computer Emergency Response Team
14	CEWiT	Centre of Excellence in Wireless Technology
15	CHD	Chemical Department
16	DDUGYJ	Deen Dayal Upadhyaya Gram Jyoti Yojana
17	DEPwD	Department of Empowerment of Persons with Disabilities
18	DoT	Department of Telecommunication
19	DPDP	Digital Personal Data Protection
20	DSCI	Data Security Council of India
21	DST	Department of Science and Technology
22	EEE	Electrical and Electronic Equipment
23	EPR	Extended Producer Responsibility

24	ESS	Energy Storage Systems
25	ETD	Electro Technical Department
26	ETSI	European Telecommunications Standards Institute
27	EV	Electric Vehicle
28	FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
29	GCCs	Global Capability Centres
30	GoI	Government of India
31	GPAI	Global Partnership on Artificial Intelligence
32	ICT	Information and Communication Technology
33	IEC	International Electrotechnical Commission
34	IoT	Internet of Things
35	IPDS	Integrated Power Development Scheme
36	IS	Indian Standard
37	ISGF	India Smart Grid Forum
38	ISO	International Organization for Standardization
39	ITU	International Telecommunication Union
40	IUDX	India Urban Data Exchange
41	LITD	Electronics & IT department
42	LMLC	Low Mobility Large Cell
43	M2M	Machine to Machine
44	MEITY	Ministry of Electronics and Information Technology
45	MNRE	Ministry of New and Renewable Energy
46	MoEFCC	Ministry of Environment, Forests and Climate Change
47	MoHUA	Ministry of Housing and Urban Affairs
48	MoP	Ministry of Power
49	NCRF	National Cyber Security Reference Framework
50	NDCP	National Digital Communications Policy
51	NEMMP	National Electric Mobility Mission Plan
52	NSG	National Study Group
53	NSGM	National Smart Grid Mission
54	PCD	Petroleum, Coal, and Related Products Division
55	PLI	Production Linked Incentive
56	PwDs	Persons with Disabilities
57	QT	Quantum Technology
58	R&D	Research and Development
59	RAI	Responsible Artificial Intelligence
60	RDSS	Revamped Distribution Sector Scheme
61	TEC	Telecommunication Engineering Centre
62	TED	Transport Engineering Division
63	TERI	The Energy and Resources Institute

64	TRAI	Telecom Regulatory Authority of India
65	TSDSI	Telecommunications Standards Development Society, India
66	VR	Virtual Reality
67	WCAG	Web Content Accessibility Guidelines
68	WLAN	Wireless Local Area Network
69	WPAN	Wireless Personal Area Network

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A Paradigm Shift in Energy Storage

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