# Role of IoT in Green Technology Development

**Mrs. Tejashri Prashant Jadhav and Mr. Avdhut Pandurang Shigvan**

Hirwal Education Trust's College of Computer Science and Information Technology, Mahad-Raigad, India

tejashrichavan578@gmail.com

**Abstract:** *This study paper looks at how the Internet of Things (IoT) has significantly advanced green technology and sustainable development. In order to demonstrate the Internet of Things' capacity to connect and interact with a wide range of devices and sensors, the article starts out by giving a general introduction of the technology and its underlying concepts. Given the growing global emphasis on resource efficiency and environmental conservation, integration of IoT devices and systems has emerged as a powerful tool for optimizing resource usage, reducing energy consumption, and minimizing environmental effect. The use of IoT in green technology is then explored in detail, covering a variety of industries such as energy, buildings, transportation, and agriculture. The study also explores the function of IoT in smart buildings, where automated systems driven by IoT sensors optimize energy usage by adjusting lighting, heating, and cooling based on occupancy and environmental conditions.*

**Keywords:** Internet of Things

## I. INTRODUCTION

The Internet of Things (IoT) plays a significant role in green technology by enabling the integration of smart devices and systems to optimize resource usage, reduce energy consumption, and promote sustainability. IoT devices can collect and transmit data in real-time, allowing for better monitoring and control of energy-intensive processes. In the context of green technology, IoT can be utilized in various ways. For instance, smart grids can use IoT sensors to monitor energy consumption patterns, identify inefficiencies, and enable demand-response mechanisms to balance energy supply and demand. This helps reduce energy waste and promotes the integration of renewable energy sources. IoT can also be applied in smart buildings to optimize energy usage through automated systems that adjust lighting, heating, and cooling based on occupancy and environmental conditions. This leads to energy savings and improved comfort for occupants.

Furthermore, IoT-enabled agriculture, known as smart farming, can enhance resource efficiency by monitoring soil moisture, weather conditions, and crop health. This data-driven approach enables precise irrigation, reduces water waste, and minimizes the use of pesticides and fertilizers.

Overall, IoT in green technology empowers industries and individuals to make informed decsisions, conserve resources, and contribute to a more sustainable future.
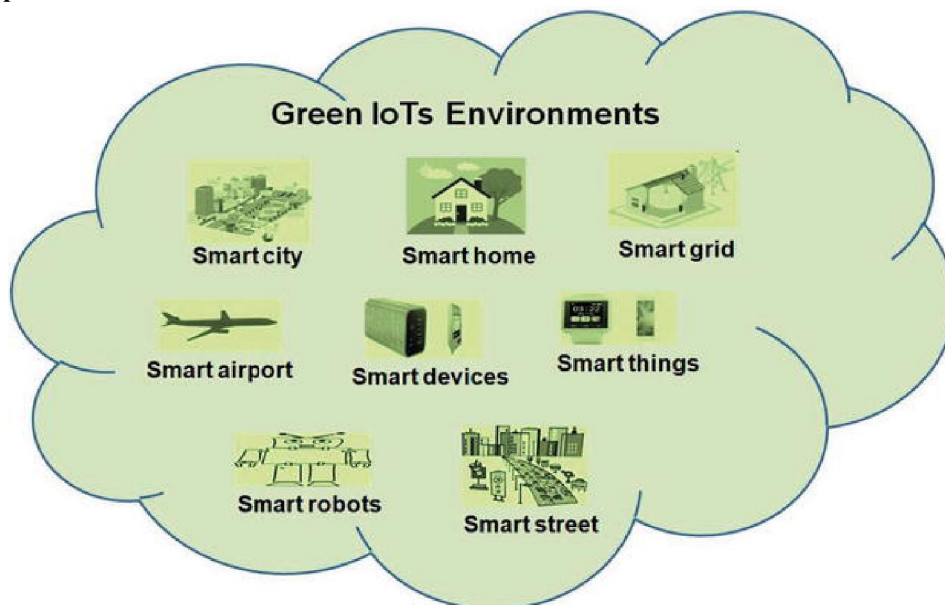
In the energy sector, the paper examines how IoT-enabled smart grids facilitate real-time monitoring and control of energy consumption, enabling demand-response mechanisms and the integration of renewable energy sources. It also explores the potential for IoT to enhance energy efficiency in industrial processes and promote the adoption of clean energy solutions.

In the agricultural sector, the paper explores the concept of smart farming, where IoT sensors monitor soil moisture, weather conditions, and crop health to enable precise irrigation, reduce water waste, and minimize the use of pesticides and fertilizers.

Source:https://www.speranzainc.com/green-iot-sustainable-design-and-technologies/

**Real-life examples of Green IoT:**



Source: https://www.intechopen.com/chapters/65203ss

**Smart Grid**

The smart grid is a communication network that collects data from many electrical system sensors to help control energy sources and consumer consumption. It refers to the grid's capacity to dynamically adjust and re-adjust dynamically in order to supply electricity at the best possible quality and price. This helps to coordinate the amount of

energy consumed to ensure the safety and security of the power network. The Smart grid uses many renewable energy sources, including thermal power plants, solar power, wind power plant, and nuclear power plant.
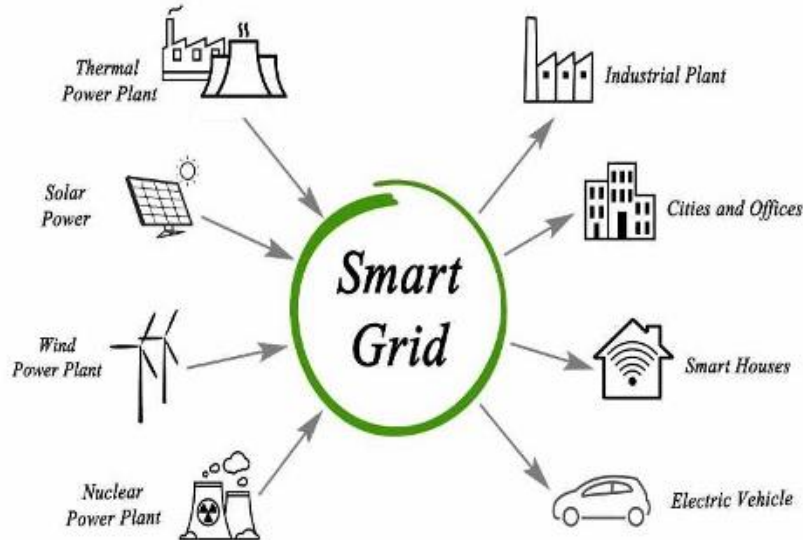


Smart grid *(source: Getting ready to operate the smarter grid | Smart Energy International (smart-energy.com))*

**Smart Cities**

IoT may be defined as the effective use of energy to allow a smart world that is sustainable. To turn big cities into sustainable living places, equipping them with green IoT devices is a promising solution. This will bring benefits such as efficient use of energy, reduced $CO_2$ emissions, and increased security, useful solutions to help people. The following are the components that make up a smart city:

- Waste management: the Green IoT-based waste management system collects data from many sensors and then transfers them to a common data center, where the data will be analyzed with the aim of optimizing the collected waste.
- Intelligent transportation system: building smart roads with green IoT devices will give suggestions on the most suitable route when there are obstacles ahead, weather reasons or traffic accidents, traffic jams.
- Safe city: this is a combination of public announcement systems, fire control management, and digital video monitoring.
- Smart building: efforts focus on lowering energy usage by redefining building functions including lighting, heating, and air conditioning.
- Smart street lights: this involves controlling the transformers to adjust the lighting level appropriately at night or during the day with changing weather conditions.
- Smart parking: uses a real-time vehicle tracking system to make suggestions for the nearest available parking in the city.

**Smart Manufacturing and Smart Factories**

An era with a system that integrates real-world manufacturing development and virtual projects in cyberspace with the rise of the Internet of Manufacturing Things (IoMT). Machines will operate automatically with little or no human intervention. Good examples of this are smart manufacturing, smart factory, and The Industrial Internet of Things (IIoT).

Smart Industrial Plants and Machine to Machine Communications:

- Firstly, attach RFID tags to the production products.
- Secondly, when the RFID scanner scans the tag, it triggers the relevant event.
- Finally, as a result, an M2M situation emerges, in which the RFID reader interacts directly with the robot without the need for human interaction. At the same time, a WSN may monitor a machine's vibrations to check its health and can trigger an event if the vibrations exceed a certain level. When the robot receives an emergency shutdown event, it instantly ceases to work.

- This saves energy by delivering real-time event data and ensuring that machines are not running needlessly. Furthermore, the increased focus on green M2M communications should help to minimize the amount of energy used by M2M subsystems.

**Intelligent transportation system (ITS)**

ITS provides overseeing traffic and gives improved interfaces to transport administrations with the benefit of effectively overseeing traffic, keeping freight on time, and giving customers real-time access to view current location and predict arrival time to a specific location determined via RFID, NFC, and sensors. The devices also help collect information related to transportation products to help businesses respond quickly to market changes. Businesses that are effectively applying this technology, such as Walmart and Metro. Increased use of green transportation options can also help to reduce the need for expensive infrastructure usage investments and unpopular traffic restrictions.

**Smart Healthcare**

A data center that allows sharing of patient medical records between hospitals. IoT devices used by patients will continuously check heart rate, blood pressure, body temperature, etc. to send information to the data center when the patient is anywhere. Through the analysis process, it will send a warning about the current health status of the patient to the medical staff taking care of and will send medical rules to the patient. Some green IoT applications in smart health are as follows:

- Physical activity monitoring for the elderly: using body sensors to track activities, using GPS to help track current location for elderly people with memory-related health conditions
- Sleep control: with sensors designed for beds, they help monitor mattress stresses, sleep movements, heart rate, and breathing patterns. It applies smart data collection methods to ensure patient privacy preservation.
- Patient's surveillance: with medical rules integrated into IoT devices such as sensors or biometrics, will help monitor and monitor patients (outpatients, inpatients, or chronic diseases such as heart, lung, blood) or medical devices to avoid potentially dangerous situations (such as wrong dose, wrong medication, etc.) or for newborn identification purposes (to avoid bias). With the desire to improve the quality of care, reduce costs and improve service access.
- Smart sports: Real-time statistics of a player in sports are essential for coaches to make plans for the future, and will have proper nutrition.

**Smart Agriculture**

Green IoT will assist the agriculture industry in solving major issues such as climate change leading to water shortages, limited land availability, and managing the cost. The combination of IoT and CC reduces power consumption. Green IoT and green nanotechnology appear as satisfactory solutions to create smart and sustainable agriculture and food industry.

Smart agriculture involves applying the right amount of inputs (fertilizer, pesticides, and water), monitoring environmental impacts, and completing pre-and post-harvest operations. Various efficient approaches, such as smart insect detection, smart underground sensors, and irrigation systems, have been designed to perform tasks for smart agriculture.

**Sensor based smart dustbins**

Garbage overflow in public areas can be prevented by using these environmentally friendly Internet of Things dustbins.

Using an Internet of Things (IoT)-based strategy, waste management can be optimized by having sensors continuously check the smart dust bins' fill level in real time. A garbage collection's optimum routes and information for collection are provided by an IoT middleware that stores and processes the data. Residents can use the smartphone app to control waste disposal, and it also assists garbage truck drivers in creating waste-optimized routes.

The 4041 cities in the nation will have their streets, roads, and infrastructure cleaned as part of the "Swachh Bharat Abhiyan" initiative, which was started by the Indian government.

IoT technologies have made it possible to create smart bins with sensors that can detect the amount of rubbish in the dustbins and send signals to the relevant authorities to dispose of the trash. Furthermore contributing to energy reduction is the IoT-based solution's ability to generate effective garbage truck routes.

**Smart watering of plants for irrigation**

Applications utilizing analytics on sensor data.

Using inexpensive Internet of Things (IoT) devices, smart irrigation builds cyber-physical systems that can irrigate plants in response to real-time analytics and data collection. To ensure that plants receive the proper amount of water, the sensors monitor a variety of factors, including temperature, humidity, and soil moisture. It promotes environmental sustainability by conserving water and labor while maintaining quality.Using smart irrigation as a case study, researchers have devised a hybrid technique that combines agile methodologies and IoT technologies. As a result, less water is used overall for irrigation, and real-time monitoring of the reservoir's water level and plant health is enhanced. In addition to IoT, edge computing and machine learning approaches have been utilized to forecast plant watering needs.

## II. CONCLUSION

The impact of IoT on environmental sustainability and its role in green technology have been examined in this research paper. It is clear from statistical analysis and review of pertinent data that IoT is important for encouraging green practices. The present study offers a thorough examination of the Internet of Things' role in green technology, emphasizing its capacity to transform resource management, mitigate environmental effects, and foster a more sustainable future. In order to create a greener environment, green IoT will undergo substantial changes in the future. We will witness sensors, machines, drones, and other devices interacting with one another on a daily basis to perform tasks intelligently for the environment that is sustainable and green. In addition to helping other industries grow sustainably and protect the environment, green IoT has a direct effect on the IoT sector. Green IoT will eventually use sustainable technology and design.

The results of this study demonstrate how IoT can help create a more environmentally friendly future. Smart grids, smart buildings, and smart agriculture,smart irrigation systems are examples of IoT technologies that we can use to increase energy efficiency, lower carbon emissions, and preserve important resources.

In summary, IoT has a bright future in green technology, and its continuous development and integration into a variety of industries promise to be very beneficial. IoT has the potential to be a key tool for tackling environmental issues and advancing a greener, more sustainable world with additional study, creativity, and cooperation.

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