



# The Ubiquity and Significance of Electrical Engineering in Daily Life

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## ABSTRACT

Electrical engineering is a fundamental discipline that has a huge impact on modern life by helping to develop and improve various technologies on which we rely every day. Electrical engineering is essential to the development of the modern world's infrastructure, from power generation and distribution to developments in consumer electronics, healthcare, transportation, and communication networks. This study examines the importance and pervasiveness of electrical engineering in day-to-day life, emphasising how advancements in the discipline have raised living standards, promoted international connectivity, and tackled sustainability issues. Additionally, it looks into the current developments and prospective future directions of electrical engineering, particularly with regard to the integration of renewable energy, the development of smart systems, and the possibility of advances in artificial intelligence, quantum computing, and autonomous technologies.

**Keywords :-** electrical engineering, power, IoT, transportation, vehicle, device, consumer, smart grid, 5g, etc.

## 1. INTRODUCTION

In the 20th century, electrical engineering made a substantial contribution to technological advancements. The widespread usage of electric energy and its benefits are the outcome of these contributions. Alternative energy sources lack certain desired qualities that electric energy possesses. These characteristics include the speed with which electric energy can be transferred, the ease with which it can be transformed into and out of other types of energy, and its capacity to be distributed across wide areas.

When enormous amounts of energy are produced in one place and dispersed to locations where they are required, economics results. A key element in achieving these economics is the ease of transportation to geographically disparate locations. Information can spread quickly when it takes the form of electric signals. Consequently, the efficiency of data processing, control, and long-range communication systems is improved. The system's viability is frequently determined by the rate at which energy is transported. Electric energy is typically useless as a goal in itself. Other types of energy are typically transformed into electric energy at the input and back again at the output in most applications. The electric energy is converted between input and output and sent to the intended location in a usable way. Motors are converters that supply mechanical energy to run a factory's equipment. The power plant's steam-driven turbo generator then transforms mechanical energy into electric energy to run the motor. Similar to this, a television system's sound and visual data are transformed into electrical signals at the studio using vidicons and microphones. In the receiver, cathode-ray tubes and loud speakers convert the data to

optical and auditory formats. The utilisation of electric energy depends on the availability of devices that can read energy and execute energy conversion. Electric energy is used in a wide range of control, communication, and instrumentation systems thanks to these conversion mechanisms and the typically modest size of electric components.

### **Electrical engineering's usefulness in modern times**

Electrical engineering is more crucial than ever in the linked world of today. Electrical engineering plays a role in practically every area of our daily lives. Electrical engineers have created and constructed the innumerable systems and gadgets we use every day from the time we get up until we go to bed. The foundation of contemporary infrastructure is electrical engineering, which powers everything from communication networks and transportation systems to medical facilities and entertainment centres. Global connectivity, national security, and economic growth all depend on it. Furthermore, electrical engineering is essential to solving urgent issues like sustainable development and climate change. Electrical engineers are contributing to the creation of a more sustainable future for future generations by creating renewable energy technologies, increasing energy efficiency, and streamlining power distribution networks.

## **2. OBJECTIVE OF THE STUDY**

1. Investigate how electrical engineering advancements improve the quality of life
2. To study communication technology in daily life
3. To investigate innovation healthcare & domestic use in daily life
4. To identify challenges & future prospects in electrical engineering daily life

## **3. LITERATURE REVIEW**

Electrical engineering is used in many aspects of home living, including lighting, entertainment systems, and household appliances. Hughes (2018) asserts that the fundamental understanding needed to create the electrical systems that drive common household objects is provided by electrical engineering. Circuit design, power management, and motor control principles are used in the design of appliances such as microwaves, washing machines, and refrigerators (Hughes, 2018). Reducing domestic energy usage and carbon footprints has been greatly aided by the development of energy-efficient household appliances that take advantage of advancements in electrical engineering (Sze, 2017).

One of the main forces behind the transformation of transportation has been electrical engineering. One of the most important instances of how electrical engineering is changing mobility is the emergence of electric cars (EVs) and their integration into public transit systems. The advancement of electric powertrains, battery management systems, and charging infrastructure has sped up the adoption of EVs, claim Cuk and DePillis (2019). In order to increase EVs' efficiency, affordability, and sustainability, electrical engineers are aiming to improve battery technology (IEEE, 2020).

One of the most important industries where electrical engineering has had a big influence is telecommunications. Electrical engineering concepts pertaining to signal processing, power control, and network optimisation are essential to the construction of communication networks, both wired and wireless. Zhang et al. (2019) examine the telecommunications infrastructure and point out how electrical engineers have contributed to the current state of global connection by advancing the development of satellite communications systems, mobile networks, and high-speed internet.

Developments in electrical engineering, particularly in the design and development of medical devices, have greatly benefited the healthcare industry. Electrical engineering, according to researchers like Kumar et al. (2018), has made it possible to produce vital medical technologies like therapeutic equipment, life-support systems, and diagnostic gadgets. Electrical concepts including signal processing and circuit design are used in the construction of pacemakers, MRI machines, and electrocardiograms (ECGs) (Kumar et al., 2018).

## 4. APPLICATIONS IN DAILY LIFE

### 4.1 Generation and Distribution of Power

The production and delivery of electricity is one of electrical engineering's most important accomplishments. To guarantee a steady supply of energy, electrical engineers develop and operate distribution networks, transmission lines, and power plants. Electrical engineering is at the forefront of developing sustainable and effective energy solutions thanks to developments in renewable energy technologies like solar panels, wind turbines, and smart grids.

**4.1.1 The electrification of cities:** The crucial significance that electrical networks play in urban settings is shown by the fact that modern cities mostly rely on intricate electrical infrastructures to power residences, commercial buildings, and public functions. Electrical engineers created and manage these grids, which serve as the foundation of urban life by distributing electricity to a diverse range of customers. Everything from home heating and lighting to company operations, public transit, and vital services like schools and hospitals are supported by this infrastructure. It promotes energy sustainability and efficiency in cities by guaranteeing a steady supply of electricity and making it easier to incorporate renewable energy sources into the system.

**4.1.2 Renewable Energy:** Reliance on fossil fuels is lessened by renewable energy sources like wind and solar power. Because fossil fuels, such as coal and oil, are limited and detrimental to the environment because of greenhouse gas emissions, this change is essential. Sustainable energy production is made possible by electrical engineering's integration of renewable energy systems, which reduces environmental impact. Electrical engineers have developed solutions for this process, such as constructing efficient wind turbines and solar panels, as well as the infrastructure needed to transfer this energy efficiently. Energy security and resilience in the face of growing global energy demands are guaranteed by renewable energy, which also aids in the fight against climate change.

**4.1.3 Smart Grids:** Refers to advanced electrical systems designed to improve the efficiency and reliability of electricity distribution. Unlike traditional grids, which follow a one-way flow of electricity from power plants to consumers, smart grids integrate digital technology and two-way communication systems. These features allow for real-time monitoring, automated control, and dynamic adjustment of electricity supply based on demand. Smart grids also enable the integration of renewable energy sources, such as solar and wind, by managing their intermittent nature and storing excess energy in batteries. This technology reduces energy waste, enhances grid reliability, and supports a sustainable energy future.

## 5. COMMUNICATION TECHNOLOGIES

The development of communication technologies that characterize contemporary connectedness has been significantly influenced by electrical engineering. It offers the framework for devices and infrastructure that enable smooth communication on a worldwide basis.

**5.1 Telecommunications:** For effective data transmission, electrical engineers create technologies like fibre optics, cellular networks, and Wi-Fi. These technologies serve as the foundation for worldwide connectivity by facilitating quick communication via phone calls, messages, and high-speed internet access.

**5.2 Internet of Things (IoT):** IoT uses the internet to link commonplace gadgets like wearable technology, security cameras, and smart thermostats. By ensuring effective data transmission and energy consumption in various gadgets, electrical engineering contributes to the convenience and intelligence of homes and workplaces.

**5.3 Communication via Satellite:** Services like GPS, worldwide broadcasting, and internet access in remote locations are made possible by satellites built using electrical engineering principles. Because they offer real-time data for rescue and recovery efforts, they are also essential in disaster management.



## 6. INNOVATIONS IN HEALTHCARE

Through the introduction of technologies that improve patient care, diagnosis, and treatment, electrical engineering has completely transformed the healthcare industry. By facilitating early detection and accurate medical procedures, these advancements not only increase efficiency but also save lives.

**6.1 Diagnostic Tools: MRI scanners:** Strong magnets and electrical systems are used in magnetic resonance imaging (MRI) to provide finely detailed images of inside body structures. These non-invasive scans are essential for identifying anomalies such as joint problems, brain illnesses, and tumours.

**6.2 CT Scanners:** Computed Tomography (CT) produces cross-sectional images of the body by combining computer technology and X-rays. High-resolution imaging and precise control are made possible by electrical engineering, which helps with the diagnosis of diseases like infections, cancer, and fractures.

**6.3 X-ray Machines:** X-rays take pictures of bones and tissues by using electromagnetic radiation. By lowering radiation exposure and increasing image clarity, electrical engineers improve these systems for efficiency and safety.

**6.4 Ultrasound Devices:** High-frequency sound waves and electrical components are used in ultrasound to produce live images of tissues and organs. It is frequently used to diagnose cardiac and stomach disorders as well as in prenatal care.

**6.5 ECGs, or electrocardiograms:** ECG devices capture the electrical activity of the heart, which aids in the detection of heart attacks, arrhythmias, and other cardiac conditions.

## 7. TRANSPORTATION SYSTEMS

Transportation has changed dramatically as a result of electrical engineering's contributions to its efficiency, sustainability, and technical advancement. Electrical engineers are essential in developing and refining transportation solutions, from private automobiles to extensive public transportation networks.

**7.1 EVs, or electric vehicles:** EVs are a sustainable substitute for conventional fuel-based automobiles because they are propelled by electric motors and battery systems. For general use, electrical engineers strive to improve battery performance, range, and charging infrastructure.

**7.2 Public Transportation:** For effective and environmentally responsible urban transportation, electrified trains, metros and trams are available. Overhead power lines and electric rail systems are designed and maintained in part by electrical engineers.

**7.3 Traffic Control Systems:** Automated monitoring systems and smart traffic lights maximise vehicle flow while lowering pollutants and traffic. For intelligent traffic solutions, electrical engineers create sensors, cameras, and algorithms.

**7.4 Autonomous Vehicles:** Sensors, electric motors, and AI-powered systems created with electrical engineering experience are all necessary for self-driving cars. These cars promise less human error and safer roads.

**7.8 Aviation and maritime transport:** Modern ships and aero planes are powered by electrical systems, which enhance energy economy, safety, and navigation. Emerging as sustainable alternatives are innovations such as electric ferries and hybrid-electric aircraft.

## 8. CONSUMER ELECTRONICS

One of the most obvious and significant uses of electrical engineering is consumer electronics, which improve the convenience, connectedness, and enjoyment of modern living. Electrical engineers create and develop technology that improve daily life, from personal gadgets to household appliances.

**8.1 Domestic Appliances:** Air conditioners, microwave ovens, washing machines, and refrigerators are a few examples. These devices' energy efficiency and functionality are optimised by electrical experts, which lowers electricity usage while enhancing performance.

**8.2 Entertainment systems:** Gaming consoles, streaming devices, sound systems, and televisions are a few examples. For smooth communication, high-quality audio, and sophisticated images, these technologies rely on electrical engineering.

**8.3 Individual Electronic Devices:** Smartwatches, tablets, computers, and smartphones are a few examples. Their quicker processing speeds, better battery life, and compact designs are all powered by electrical engineering.

**8.4 Smart Home Appliances:** Security cameras, lighting controls, and smart speakers are a few examples. These devices integrate IoT and electrical engineering, enabling remote control and automation through smartphones or voice commands.

**8.5 Wearable Technology:** Health monitors, virtual reality headsets, and fitness trackers are a few examples. These are made by electrical engineers to monitor activity, improve immersive experiences, and deliver health data in real time.

## 9. CHALLENGES AND FUTURE PROSPECTS

### 9.1 Renewable Energy Source Integration:

**Challenge:** Integrating intermittent energy sources like solar, wind, and hydro into current electrical networks presents major issues as the globe moves towards renewable energy sources. In contrast to conventional power plants, renewable energy output is subject to weather fluctuations, which can lead to problems with grid stability.

### 9.2 Efficiency and Energy Storage:

**Challenge:** The capacity, cost, lifespan, and scalability of the energy storage technologies available today, including lithium-ion batteries, are all constrained. One major challenge is effectively storing energy produced by renewable sources and guaranteeing its availability during periods of high demand.

### 9.3 Cybersecurity for IoT devices and smart grids:

**Challenge:** Vulnerabilities are introduced by the growing integration of smart devices and the Internet of Things (IoT) into electrical systems. Due to their internet connectivity, smart grids, electric vehicles (EVs), home automation systems, and industrial control systems are all vulnerable to cyberattacks.

### 9.4 Electrical component reliability and miniaturization:

**Challenge:** It gets harder to guarantee the dependability of electrical components in small systems, such as wearables, smartphones, and medical equipment, as electronic gadgets get more potent and smaller. Heat management and power efficiency are further complicated by the need for high-performance components in confined locations.

## 9.5 Maintenance and Ageing Infrastructure:

**Challenge:** In many regions of the world, a large portion of the electrical infrastructure is outdated and requires modernization. Electrical system replacement and maintenance provide logistical and economic difficulties, particularly in urban and industrial environments.

## 9.6 Electrical engineering's effects on the environment and society:

**Challenge:** From raw material mining to electronic trash, the manufacture, usage, and disposal of electrical devices and components can have a substantial negative influence on the environment. Furthermore, communities and ecosystems may suffer as a result of the exploitation of materials for batteries and other components.

# 10. FUTURE PROSPECTS

## 10.1 Developments in Automation and Artificial Intelligence (AI):

**Prospect:** AI and machine learning will have a big impact on electrical engineering in the future. AI can enhance electrical system operation and design by forecasting maintenance requirements and optimising power distribution. Additionally, automation driven by AI will help reduce human error in industrial applications and improve system control.

**Impact:** By improving electrical systems' capacity to learn and adjust to changing circumstances, such as controlling energy use or anticipating infrastructure failure sites, artificial intelligence (AI) and machine learning can make them smarter.

## 10.2 Smart Grid and Decentralised Energy Systems:

**Prospect:** It is anticipated that the deployment of smart grids, which optimise the distribution of electricity using real-time data, would completely transform the way energy is controlled on a worldwide scale. Additionally, communities will be able to become more self-sufficient and less dependent on centralised power generation thanks to decentralised energy systems like microgrids and local renewable energy generation.

**Impact:** This change will allow for the increased integration of renewable energy sources and result in more cost-effective, energy-efficient, and resilient energy systems.

## 10.3 The Development of Autonomous and Electric Vehicles:

**Prospect:** Because of advancements in battery technology and the growth of charging infrastructure, electric vehicles (EVs) are set to displace conventional vehicles that run on fossil fuels. Furthermore, it is anticipated that autonomous vehicles—which mostly rely on electrical systems for communication and navigation—will become widely used in the ensuing decades.

**Impact:** While autonomous vehicles will improve transportation's safety, effectiveness, and accessibility, the broad usage of EVs will help lower greenhouse gas emissions.

## 10.4 New Materials and Quantum Computing:

**Prospect:** Electrical engineering stands to undergo a radical transformation thanks to quantum computing, which makes use of the ideas of quantum physics. Quantum computing has the potential to advance simulation, optimisation, and material discovery by resolving issues that are now unsolvable by traditional computers.

**Impact:** The creation of quicker, more effective electrical systems and components will be made possible by new materials like topological insulators and superconductors. Better energy storage options, quicker data processing, and more effective power transmission can all be made possible by these materials.

### 10.5 Solutions for Sustainable Energy:

**Prospect:** Electrical engineers will be essential in creating sustainable energy systems as the world's energy needs grow and the need to cut carbon emissions grows more pressing. This entails developing systems for effective energy storage, transmission, and grid integration in addition to enhancing renewable energy technologies (solar, wind, hydro, and geothermal).

**Impact:** Decentralised renewable energy systems will probably be used much more in the future, which will further lessen reliance on fossil fuels and improve energy security.

### 10.6 5G and beyond:

**Prospect:** Electrical engineering will be significantly impacted by the rollout of 5G networks and upcoming developments in wireless communication technology. The expansion of IoT devices, smart cities, and autonomous systems will all be made possible by 5G's promise of faster and more dependable connection.

**Impact:** A more connected world where people, infrastructure, and gadgets can communicate easily will result from faster data transmission and the growth of the Internet of Things. This will create new chances for innovation in a variety of industries.

### 10.7 Green engineering and sustainability:

**Prospect:** The drive for sustainability will have a significant impact on electrical engineering in the future. The development of energy systems and technologies with the least possible negative impact on the environment, the design of energy-efficient systems, and the reduction of carbon footprints will all be spearheaded by electrical engineers.

**Impact:** Electrical engineering will move towards a more environmentally friendly and sustainable future as a result of the shift to greener technologies like smart buildings, electric heating, and sustainable manufacturing.

## 11. CONCLUSION

Electrical engineering has become a vital force in modern civilisation, influencing almost every area of daily life. The discipline has made enormous and revolutionary contributions to everything from the smooth functioning of home appliances to the infrastructure that underpins international communication, transportation, and healthcare. By creating cutting-edge solutions like smart grids, renewable energy technologies, and improvements in energy storage, electrical engineers will continue to be at the forefront of tackling societal challenges relating to energy sustainability, climate change, and technological integration. Furthermore, the area is about to undergo yet another upheaval thanks to promising advancements in automation, artificial intelligence, and quantum computing. But issues like energy storage constraints, cybersecurity threats, and the requirement for modern infrastructure continue to be major obstacles. Electrical engineering will continue to propel advancements towards a more technologically sophisticated, sustainable, and interconnected future if these obstacles are overcome.



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