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Technique Polytechnic Institute

Hooghly - 712102

GRATITUDE TO – Mr. Tapas Kumar Saha, Chairman, GB

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DEPARTMENT OF ELECTRICAL ENGINEERING
Technique Polytechnic Institute
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West Bengal - 712102

Editorial

It is said that, "Without continual growth & progress, such words as improvement, achievement & success have no meaning". We are elated for our exuberant students for their effort in the present edition of **"Voltaffair"**. *It is pleasing to see that the seed of interest once sown is now shaping up as a full grown tree with all its branches spread. The branches providing shade of wisdom and knowledge. Nothing is more satisfying than to watch the joint effort of all. Till then we shall be nurturing with motivation.*

Vision

To become a nationally recognized centre of excellence in Electrical Engineering

Mission

- To provide training to the students by promoting active learning, critical thinking and engineering judgment coupled with business and entrepreneurial skills to succeed as leading engineers

- To prepare students with the capability to meet ever-growing socio-economic necessity of the industry and society

- To create opportunity to encourage self-learning leading to competence of lifelong learning

Programme Educational Objectives (PEOs)

PEO.1. To produce Electrical engineers having strong foundation in mathematics, science, basic engineering & management for providing solution to industrial problem

PEO.2. To train students with good practical exposure to test & verify the characteristics of common electrical equipment/machines/control system & to develop the skill to analyse, appreciate & interpret the data for engineering applications

PEO.3. To inculcate professional & ethical attitude, communication & team work skills

PEO.4. To inculcate the ability to relate engineering issues from social perspective for truly contributing to the needs of society

PEO.5. To develop attitude to deal with multidisciplinary approach in self-learning

Programme Outcomes (POs)

1. Basic and Discipline specific knowledge: Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.

2. Problem analysis: Identify and analyse well-defined engineering problems using codified standard methods.

3. Design/ development of solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

4. Engineering Tools, Experimentation and Testing: Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

5. Engineering practices for society, sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

6. Project Management: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

7. Life-long learning: Ability to analyse individual needs and engage in updating in the context of technological changes.

PROGRAM SPECIFIC OUTCOMES

PSO-1. (Engineering knowledge and analysis)

Analyse specific technological problem relevant to electrical engineering by applying knowledge of basic science, engineering mathematics and engineering fundamentals

PSO-2. (Maintenance and technological development)

Ability to fabricate maintenance and system operation of electrical engineering devices using significant technical skills, analytical ability and uses of modern tools

PSO-3. (Application of the knowledge on society/environment)

Apply the acquired knowledge of electrical engineering assess societal, health, safety, legal and cultural issues with professional ethics and function effectively as an individual or a leader in a team to manage different projects in multidisciplinary industrial environment

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UNDER-SEA ELECTRICITY TRANSFER

SHREYAN NANDAN
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1. INTRODUCTION

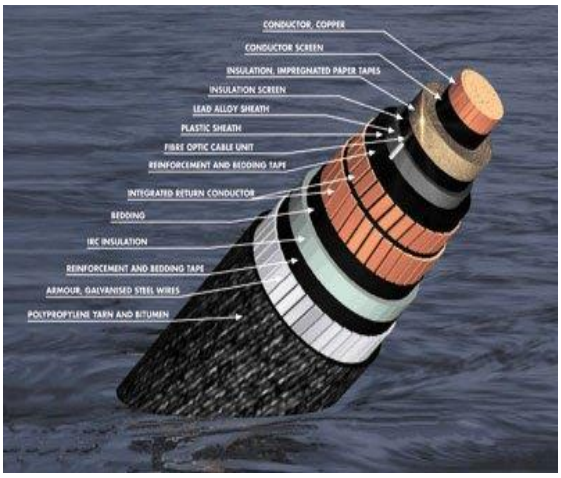
Undersea electricity transfer, also known as subsea power transmission, is a crucial aspect of electrical engineering that involves the efficient and reliable transportation of electrical energy across underwater environments. This technology is employed for various applications, including offshore power generation from renewable sources, interconnecting power grids across bodies of water, and supplying electricity to remote offshore locations.

2. CHALLENGES WITH UNDER-SEA ELECTRICITY TRANSFER

The challenges associated with undersea electricity transfer are unique and demanding. Unlike land-based power transmission, the underwater environment introduces additional complexities such as water pressure, corrosion, and the need for specialized materials and equipment. One of the primary methods for undersea electricity transfer is the use of submarine power cables. Submarine power cables are specially designed to withstand the harsh conditions of the marine environment. These cables consist of multiple layers of insulation, shielding, and protective materials to ensure the safety and reliability of the transmitted electrical power. The insulation is crucial to prevent electrical leakage and maintain the integrity of the cable over long distances.

3. ECONOMIC AND ENVIRONMENTAL ASPECTS

In addition to the technical challenges, the economic and environmental aspects play a significant role in undersea electricity transfer projects. Installing and maintaining submarine power cables can be expensive and logistically challenging. Moreover, minimizing the environmental impact is essential to ensure the sustainability of marine ecosystems. Engineers and researchers in the field work on developing innovative solutions to address these challenges and make undersea electricity transfer more viable and environmentally friendly.



4. KEY APPLICATIONS

Subsea power transmission is commonly used in various applications, including offshore oil and gas operations, renewable energy projects, and intercontinental power cable connections. It's often employed to transmit electrical power from offshore facilities to onshore locations or between offshore installations. Additionally, subsea power transmission is vital for connecting underwater power cables from offshore wind farms to the onshore electrical grid.

4.1 Connecting Offshore Renewable Energy Sources

One of the key applications of undersea electricity transfer is connecting offshore renewable energy sources, such as wind farms or tidal energy installations, to the onshore power grid. This allows for the efficient utilization of clean energy resources located in remote offshore locations. The generated electricity is then transmitted through underwater cables to onshore substations, where it is integrated into the broader electrical grid for distribution.

4.2 Interconnecting Power Grids across Bodies of Water

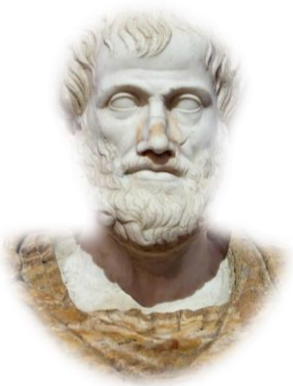
Interconnecting power grids across bodies of water is another important application of undersea electricity transfer. This can enhance the reliability and stability of power systems by enabling the exchange of electricity between different regions. In case of power shortages or emergencies in one area, electricity can be imported from another connected region through the undersea cables, providing a level of grid resilience.

4.3 Supplying Power to Remote Offshore Locations

Undersea electricity transfer also plays a crucial role in supplying power to remote offshore locations, such as oil and gas platforms. These locations often require a stable and continuous power supply for their operations. Submarine power cables facilitate the transmission of electricity from onshore facilities to these remote platforms, reducing the need for onsite power generation and storage.

5. CONCLUSION

In conclusion, undersea electricity transfer is a vital and evolving field within electrical engineering. It addresses the unique challenges posed by the marine environment and enables the efficient and reliable transmission of electrical power for various applications. As technology advances and new solutions emerge, undersea electricity transfer will likely continue to play a key role in expanding the use of offshore renewable energy, enhancing grid connectivity, and powering remote offshore locations.



We are what we repeatedly do. Excellence, then, is not an act. but a habit. - Aristotle

LI-FI: THE FUTURE OF WIRELESS COMMUNICATION

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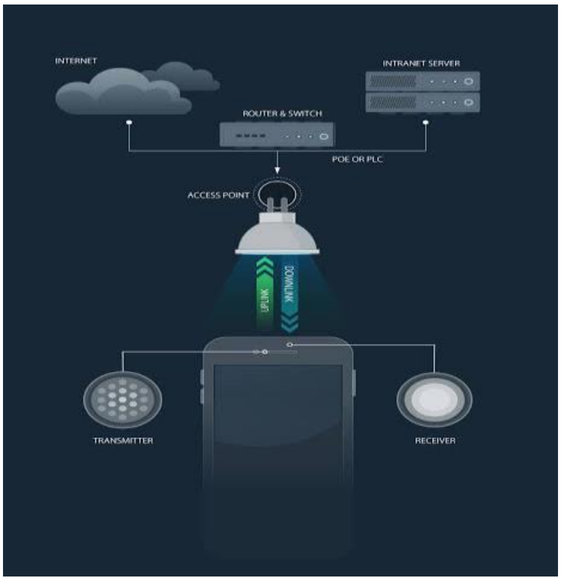
1. INTRODUCTION

Light Fidelity or Li-Fi, represents a revolutionary wireless communication technology that distinguishes itself by utilizing visible light to transmit data. In contrast to traditional Wi-Fi, which relies on radio waves, this ground-breaking technology was introduced by Harald Haas in 2011. How Li-Fi Works: Li-Fi operates by modulating the intensity of light emitted by LED (Light Emitting Diode) bulbs at high speeds. These variations are undetectable to the human eye, allowing for data transmission. Specialized receivers, typically integrated into devices like smartphones or laptops, capture the light signals and convert them back into data.



2. INCLUDING COMPONENTS

1. LED Bulbs
These serve as the light source for Li-Fi communication.

2. Photodetector
A light-sensitive receiver that detects the light signals from the LED bulbs and converts them back into data.

3. Signal Processing Unit
This unit processes the data received from the photodetector, demodulates it, and prepares it for use in various applications.

4. Communication Device
A device such as a smartphone, tablet, or computer with a Li-Fi-compatible receiver that can decode and use the transmitted data.

5. Li-Fi Driver
Software or hardware components that control the modulation and demodulation of the light signals for data transmission.

6. Li-Fi Access Point
A device that manages the Li-Fi network and connects it to other networks, such as the internet.

3. ADVANTAGES OF LI-FI

1. High Speed
Li-Fi provides incredibly fast data transfer, reaching gigabit speeds, and ideal for data-intensive applications.

2. Enhanced Security
Li-Fi is more secure as it doesn't pass through walls, reducing the risk of interception.

3. Interference-Free
It's immune to electromagnetic interference, making it suitable for sensitive environments.

4. Energy Efficiency
Li-Fi uses energy-efficient LED bulbs, saving both energy and costs.

5. Integration and Dual-Purpose

Li-Fi can be integrated into existing lighting systems, offering both illumination and data communication in one.

4. PROBLEMS OF LI-FI

1. Limited Range: Li-Fi's range is restricted to the line of sight, and it doesn't perform well through walls or obstacles, which can limit its applicability in certain scenarios.

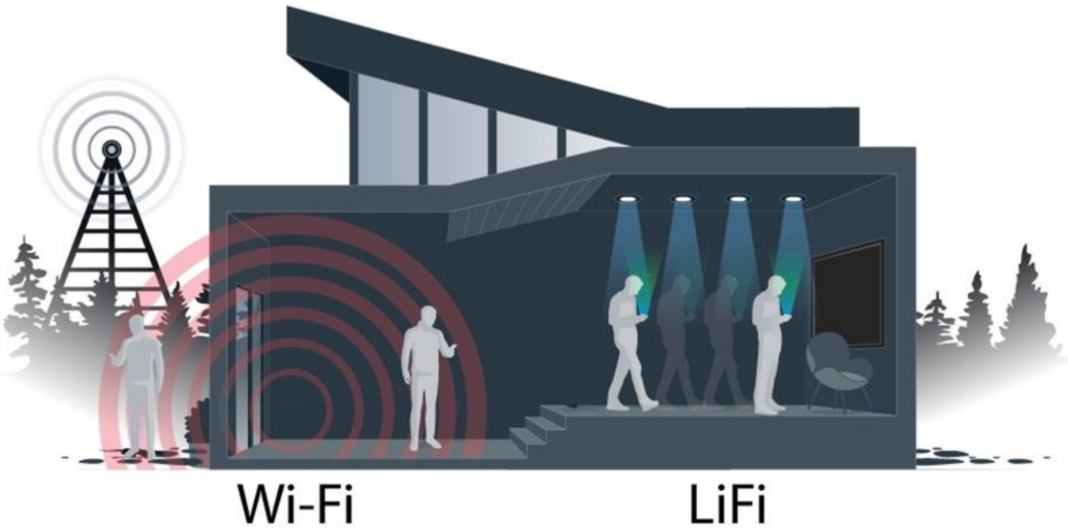
2. Susceptibility to Ambient Light: Bright sunlight or other strong light sources can interfere with Li-Fi signals, potentially causing disruptions.

3. Infrastructure and Cost
Retrofitting or implementing Li-Fi infrastructure can be costly, especially when replacing existing lighting systems with Li-Fi-enabled LEDs.

4. Mobility
Li-Fi primarily suits stationary devices, making it less suitable for mobile devices that require continuous connectivity while moving.

5. Standardization
Li-Fi lacks standardized protocols, which can hinder its widespread adoption and interoperability with different devices.

5. CONCLUSION
This system can be used for internet access, indoor navigation, healthcare, underwater communication, secure environments, and more.



All truths are easy to understand once they are discovered; the point is to discover them. - Galileo Galilei

TELESCOPE: ITS HISTORY AND WORKING

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1. INTRODUCTION

The solar system is a vast and intricate celestial arrangement that revolves around a central star, the Sun. Comprising eight planets, their moons, dwarf planets, asteroids, and comets, the solar system showcases the dynamic dance of celestial bodies governed by gravitational forces. Understanding its components provides insight into the cosmos and our place within it.

2. SOLAR SYSTEM

At the heart of the solar system is the Sun, a massive, luminous ball of hot plasma. Its gravitational pull keeps the planets in orbit, with Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune circling it. Each planet boasts unique characteristics, from the scorching surface of Venus to the frigid atmosphere of Neptune. Earth, the third planet from the Sun, is our home and the only known celestial body to support life. Its diverse ecosystems, oceans, and atmosphere create a delicate balance for the existence of various species. Earth's Moon, a natural satellite, influences tides and has played a crucial role in human history and culture. Beyond the planets, dwarf planets like Pluto and Eris orbit the Sun, accompanied by a multitude of asteroids and comets. These remnants from the early solar system offer clues about its formation. The Kuiper Belt, a region beyond Neptune, is home to many icy bodies, contributing to our understanding of the solar system's outer reaches.

3. TOOLS TO STUDY THE SOLAR SYSTEM

Observing and studying the solar system requires advanced tools, and telescopes serve as invaluable instruments for astronomers. Among these, the Gran Telescopio Canarias (GTC) in Spain stands out with its remarkable capabilities. The GTC boasts a colossal primary mirror, measuring 10.4 meters in diameter, making it one of the largest optical telescopes globally.

4. TELESCOPE IN OBSERVING THE TELESCOPE

The telescope's large mirror allows for superior light-gathering capability, enabling astronomers to observe faint and distant objects with exceptional clarity. Situated at the Roque de los Muchachos Observatory on the island of La Palma, the GTC benefits from the high-altitude location, minimizing atmospheric interference and optimizing observational conditions. The GTC utilizes a variety of instruments to capture different wavelengths of light, from visible to infrared. This versatility enables astronomers to explore a wide range of phenomena, from distant galaxies to nearby planets within our solar system. The telescope's adaptive optics system further enhances image quality by compensating for atmospheric distortions. One of the key contributions of the GTC is its role in advancing our understanding of the cosmos. Observations conducted with this telescope have provided insights into the formation of galaxies, the behaviour of black holes, and the composition of exoplanets. Its cutting-edge technology and international collaborations position the GTC at the forefront of astronomical research. The solar system is a captivating cosmic ensemble, with the Sun at its centre orchestrating the movements of planets, moons, and other celestial bodies. Exploring the intricacies of our cosmic neighbourhood deepens our comprehension of the universe's vastness and complexity. Telescopes like the Gran Telescopio Canarias play a pivotal role in unravelling these cosmic mysteries, pushing the boundaries of human knowledge and expanding our view of the cosmos.

5. LONG LENS TELESCOPE

The world's longest lens telescope operates on the basic principles of optics and astronomy, employing advanced technologies to capture distant celestial objects with unprecedented clarity. The design and functionality of such telescopes involve a combination of lenses and mirrors, as well as intricate engineering to overcome challenges associated with extreme focal lengths. The primary component of any telescope, including long-lens telescopes, is the objective lens or mirror. In the case of a lens telescope, the objective lens is responsible for gathering and focusing light. The longer the focal length of the lens, the greater the magnification achieved. However, designing and constructing a telescope with an extremely long focal length comes with inherent difficulties.

5.1 Creating Long-Lens Telescope

To create a long-lens telescope, engineers utilize multiple lenses, each serving a specific purpose in the optical system. These lenses are carefully aligned to minimize aberrations and distortions that can degrade image quality. Additionally, special coatings may be applied to the lenses to reduce reflections and improve light transmission.

5.2 Designing Long-Lens Telescope

One challenge in designing a long-lens telescope is the size and weight of the lens itself. Longer focal lengths typically result in larger lenses, making the telescope bulkier and heavier. Engineers address this by incorporating lightweight materials and innovative design techniques to maintain structural integrity while minimizing weight.

5.3 Telescope's Mount and Tracking System

The telescope's mount and tracking system play a crucial role in its functionality. For a long-lens telescope to effectively observe celestial objects, it must be able to track their motion across the sky. Precision tracking systems, often employing computer-controlled motors, are implemented to compensate for the Earth's rotation and keep the telescope focused on a target for extended periods.

6. APPLICATIONS

Long-lens telescopes are frequently used in astrophotography, capturing detailed images of distant galaxies, nebulae, and other celestial phenomena. The extended focal length allows for high-magnification imaging, revealing intricate details that might be challenging to observe with shorter focal length telescopes.

Advancements in technology have led to the development of adaptive optics systems in long-lens telescopes. These systems use deformable mirrors to counteract the blurring effects of Earth's atmosphere, resulting in sharper images. This is particularly beneficial when observing faint and distant objects, as atmospheric turbulence can significantly impact image quality.

7. THE WORKING PRINCIPLE

The working principle of the world's longest lens telescopes involves utilizing multiple lenses, precision engineering, and advanced optics to achieve extreme focal lengths. The design addresses challenges related to size, weight, and atmospheric conditions, allowing astronomers and astrophotography's to explore the cosmos with remarkable detail and clarity.

The world's longest telescopes represent the pinnacle of astronomical exploration, providing unprecedented insights into the universe. These colossal structures rely heavily on advanced electrical engineering to function effectively. From intricate control systems to precise data acquisition mechanisms, electrical engineers play a pivotal role in designing, implementing, and maintaining the complex electrical infrastructure that powers these astronomical giants.

8. DESIGN AND IMPLEMENTATION OF CONTROL SYSTEMS

One fundamental aspect of electrical engineering in long telescopes is the design and implementation of control systems. These systems are responsible for precisely positioning the telescope's massive components, such as the primary and secondary mirrors, to focus on celestial objects. Electrical engineers develop intricate algorithms and control mechanisms that enable high-precision movements, compensating for factors like Earth's rotation to keep the telescope accurately pointed at the target. In addition to positioning, electrical engineers contribute to the development of stabilization systems. Given the immense size and weight of long telescopes, factors like wind and vibrations can impact their stability. Engineers integrate sensors and actuators to counteract these disturbances, ensuring a stable platform for observations. This meticulous work demands a deep understanding of control theory, sensor technologies, and real-time feedback systems. Data acquisition is another critical domain where electrical engineering expertise is indispensable. The vast amounts of data collected by these telescopes require sophisticated systems for processing and analysis. Engineers design and implement data acquisition systems that capture high-resolution images and spectra, converting analog signals from detectors into digital data for further analysis. The efficiency and accuracy of these systems are paramount for extracting meaningful information from the observations.

9. POWER DISTRIBUTION IN TELESCOPES

Power distribution is a crucial aspect of electrical engineering in long telescopes. These structures are often located in remote and challenging environments, necessitating reliable power systems. Engineers design power distribution networks that efficiently deliver electricity to various components, considering factors like voltage regulation and backup systems to ensure uninterrupted operation. Renewable energy sources, such as solar or wind power, may also be integrated into the electrical infrastructure to enhance sustainability.

9.1 Communication

Communication networks are vital for transmitting data from the telescope to research facilities for analysis. Electrical engineers design and implement robust communication systems that can handle the massive amounts of data generated during observations. This involves optimizing data transfer rates, implementing error correction mechanisms, and ensuring secure and reliable communication channels.

9.2 Development

Electrical engineers contribute to the development of innovative technologies that enhance the capabilities of long telescopes. For example, advancements in adaptive optics, a technology that compensates for atmospheric distortions in real-time, rely heavily on electrical engineering expertise. Engineers design deformable mirrors and control systems that adjust the telescope's optics on-the-fly, significantly improving image clarity.

9.3 Maintenance and Troubleshooting

Maintenance and troubleshooting are ongoing tasks for electrical engineers involved with long telescopes. These engineers work on predictive maintenance strategies, utilizing sensors and diagnostic tools to identify potential issues before they affect the telescope's performance. When problems arise, engineers must quickly diagnose and rectify electrical malfunctions to minimize downtime.

9.4 Collaboration

Collaboration is a key aspect of electrical engineering in long telescopes. Engineers work closely with astronomers, astrophysicists, and other scientists to understand the specific requirements of observations. This interdisciplinary collaboration ensures that the electrical systems align with the scientific goals of the telescope, contributing to the success of various research projects.

10. CONCLUSION

In conclusion, electrical engineering is integral to the functioning of the world's longest telescopes. The intricate control systems, advanced data acquisition mechanisms, reliable power distribution, efficient communication networks, and innovative technologies developed by electrical engineers contribute to the success of these monumental instruments. As astronomical exploration continues to push the boundaries of our understanding, the role of electrical engineering in advancing telescope capabilities remains paramount.

Give me a place to stand and I will move the earth. Give me but a firm spot on which to stand, and I shall move the earth. Give me a place to stand, and a lever long enough, and I will move the world. Give me a lever long enough and a fulcrum on which to place it, and I shall move the world. - Archimedes of Syracuse

ELECTRIC BIKES: ITS WIDE RANGE OF ADVANTAGES

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1. INTRODUCTION

Electric bikes, often referred to as e-bikes, are bicycles equipped with an electric motor to assist with pedalling. Electric bikes pedal and handle just like a regular bicycle. By and large, an electric bike will use the same parts too. The electric component is meant to augment human power, not completely replace it. It makes obstacles like hills and headwind more manageable and allows you to travel further without getting as tired. When someone hears electric bicycle, the first image they imagine may be a scooter or electric motorcycle - but they actually look pretty different. Just picture a regular bicycle, then add several electrical components to it like a motor, a battery, and a controller – all seamlessly integrated into the design. These items make up the fundamentals of all electric bicycles on the market!

2. KEY ASPECTS OF E-BIKES

Here are some key points about electric bikes

2.1. Electric Assistance

E-bikes provide electric assistance to the rider's pedalling. This assistance can be adjusted, and it makes cycling easier, especially on hills or long distances.

2.2. Types

There are various types of e-bikes, including city e-bikes for commuting, mountain e-bikes for off-road adventures, and cargo e-bikes for transporting goods. Each type is designed for specific purposes.

2.3. Battery

E-bikes are powered by rechargeable batteries. The battery's capacity determines the range and power of the electric assist.

2.4. Motor

E-bikes have an electric motor that can be located in various places, such as the hub of the wheel or near the pedals. Different motor placements offer different riding experiences.

2.5. Pedal-Assist vs. Throttle

E-bikes can operate in two primary modes. Pedal-assist mode provides electric assistance as you pedal, while some e-bikes also have a throttle, allowing you to control the motor without pedalling.

2.6. Regulations

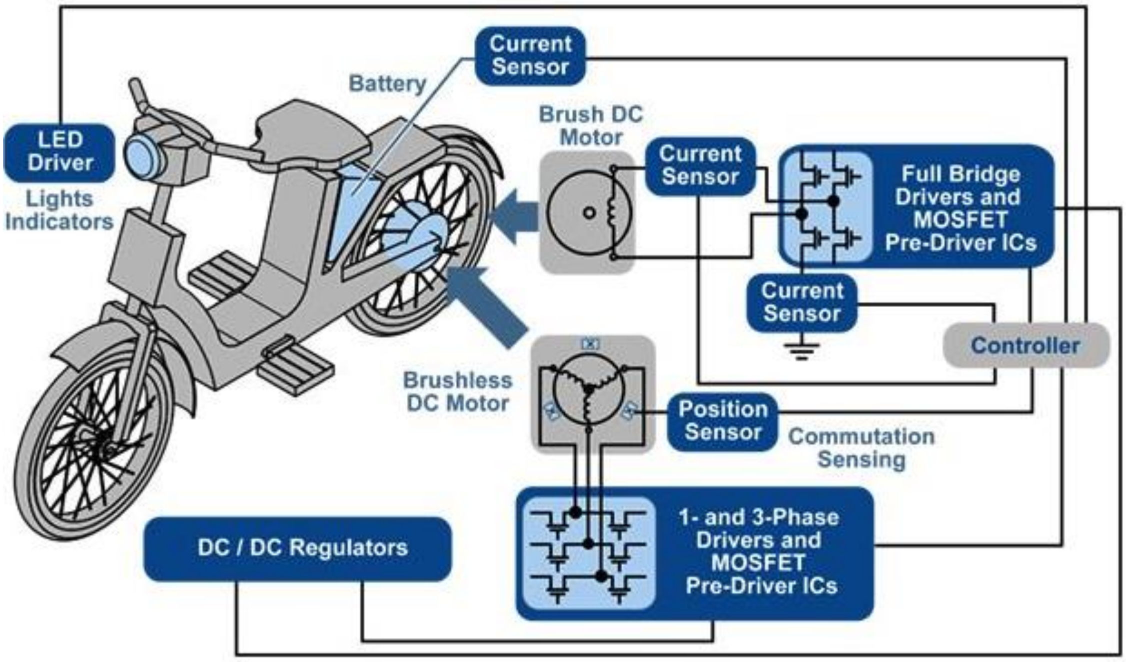
Regulations regarding e-bikes can vary by country and even by state or city. It's important to be aware of local laws and regulations before using an e-bike.

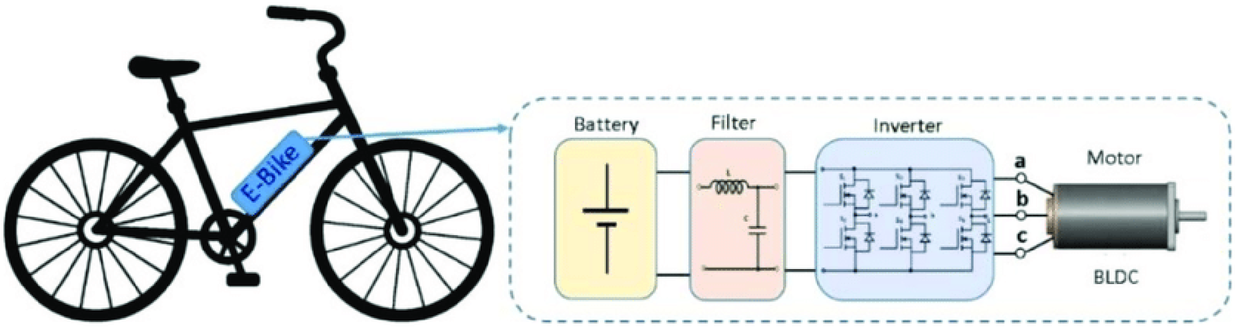
2.7. Environmental Benefits

E-bikes are considered a more environmentally friendly mode of transportation compared to traditional gas-powered vehicles, as they produce fewer emissions.

3. CONCLUSION

E-bikes have gained popularity for commuting, exercise, and recreational purposes. They offer a convenient and eco-friendly way to travel and have expanded options for people of various fitness levels and needs. Keep in mind that e-bike technology and models continue to evolve, so it's a good idea to research and test different options to find the one that best suits your needs.





The secret of change is to focus all of your energy, not on fighting the old, but on building the new. - Socrates

ULTRASONIC MOTORS AND THEIR APPLICATIONS

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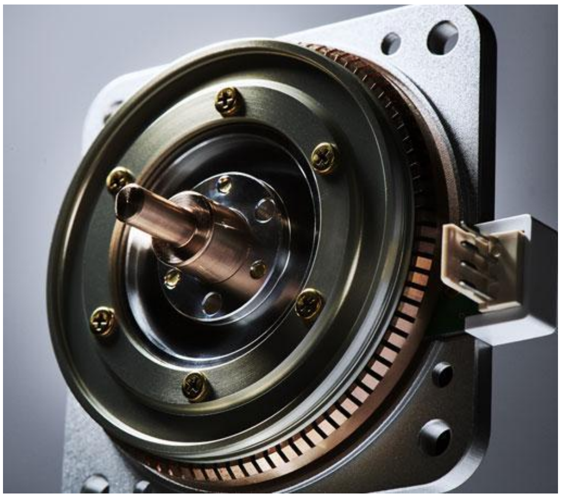
1. INTRODUCTION

Ultrasonic motors are a fascinating class of electric motors that harness the power of ultrasonic vibrations to achieve precise and efficient motion. In this comprehensive overview, we'll delve into the principles, components, working mechanisms, applications, and advantages of ultrasonic motors.



2. PRINCIPLES OF ULTRASONIC MOTORS

Ultrasonic motors operate on the principle of piezoelectricity. Piezoelectric materials exhibit a unique property where mechanical stress induces an electric charge and vice versa. The core component of an ultrasonic motor is a piezoelectric transducer, often made of ceramics like lead zirconate titanate (PZT).

3. COMPONENTS OF ULTRASONIC MOTORS

3.1. Piezoelectric Transducer

Converts electrical signals into ultrasonic vibrations and vice versa. When an AC voltage is applied, the piezoelectric element deforms, producing ultrasonic waves.

3.2. Rotor or Slider

The moving part of the motor that responds to ultrasonic vibrations. Can be a rotor rotating around an axis or a slider moving linearly.

3.3. Stator

The stationary part that generates the ultrasonic waves. It often consists of multiple piezoelectric elements arranged in a specific configuration.

3.4. Contact Material

To enhance friction and transmit the ultrasonic vibrations to the rotor or slider.

4. WORKING MECHANISM

4.1. Vibration Generation

The piezoelectric transducer is subjected to AC voltage, causing it to vibrate at ultrasonic frequencies. The stator amplifies and focuses these vibrations.

4.2. Wave Propagation

Ultrasonic waves generated in the stator travel to the rotor or slider.

4.3. Motion Induction

The ultrasonic waves create standing waves or specific vibration patterns, inducing motion in the rotor or slider.

4.4. Continuous Adjustment

The frequency and amplitude of the ultrasonic vibrations can be adjusted for precise control.

5. TYPES OF ULTRASONIC MOTORS

5.1. Linear Ultrasonic Motors

Produce linear motion.
Commonly used in applications requiring precise linear positioning.

5.2. Rotary Ultrasonic Motors

Generate rotational motion.
Applied in scenarios where precise rotation is essential.

6. APPLICATIONS OF ULTRASONIC MOTORS

Ultrasonic motors find applications in various fields due to their unique characteristics, such as precise motion control and compact design. Some common uses include:

6.1. Autofocus Mechanisms in Cameras

Ultrasonic motors are commonly employed in camera lenses for quick and precise autofocus operations, ensuring sharp and clear images.

6.2. Robotics

In robotics, ultrasonic motors contribute to accurate positioning and movement control, making them suitable for robotic arms and other fine-tuned robotic applications.

6.3. Medical Devices

Surgical instruments and medical devices benefit from the precision of ultrasonic motors, especially in applications where precise movements are crucial, such as in minimally invasive surgeries.

6.4. Aerospace

Ultrasonic motors are used in aerospace applications where space and weight considerations are critical. They find use in mechanisms that require precision in extreme environments.

6.5. Optics and Photonics

In optical systems, ultrasonic motors are employed for fine adjustments, enabling precise control over elements like mirrors, lenses, and filters.

6.6. Consumer Electronics

Ultrasonic motors are utilized in various consumer electronic devices, including DVD players, CD-ROM drives, and other gadgets where compact size and precise motion are essential.

6.7. Printers and Scanners

These motors are used in printers and scanners for precise movement of print heads or scanning components.

6.8. Precision Positioning Systems

Applications that require high-precision positioning, such as semiconductor manufacturing and testing equipment, benefit from the accuracy offered by ultrasonic motors.

6.9. Laboratory Equipment

Instruments in laboratories, like microscopes and other analytical devices, often utilize ultrasonic motors for their precision and minimal electromagnetic interference.

6.10. Industrial Automation

Ultrasonic motors play a role in various industrial automation processes where precise control and compact design are advantageous.

The versatility of ultrasonic motors makes them suitable for a wide range of applications, especially in situations where traditional electromagnetic motors may face limitations. As technology advances, we can expect to see further integration of ultrasonic motors in new and diverse fields.

7. ADVANTAGES OF ULTRASONIC MOTORS

7.1. Precise Control

High precision in both linear and rotational motions.

7.2. Compact Size

The absence of bulky electromagnetic components allows for compact designs.

7.3. Electromagnetic Interference

Ideal for applications where electromagnetic interference must be minimized.

7.4. High Torque at Low Speeds

Can deliver substantial torque even at low rotational speeds.

7.5. Quick Response Time

Rapid and accurate response to control inputs.

8. CHALLENGES AND LIMITATIONS

8.1. Temperature Sensitivity

Performance can be affected by temperature variations.

8.2. Complex Manufacturing

Fabricating precise piezoelectric components can be challenging.

8.3. Cost

Production costs may be higher compared to traditional motors.

9. FUTURE TRENDS

9.1. Miniaturization

Continued efforts to make ultrasonic motors even more compact.

9.2. Integration with Smart Technologies

Integration with sensors and smart control systems for enhanced functionality.

9.3. Diverse Applications

Expanding into new domains, driven by advancements in materials and manufacturing.

10. CONCLUSION

In conclusion, ultrasonic motors represent a remarkable fusion of physics and engineering, offering a promising future in various fields. Their ability to provide precise, compact, and interference-free motion makes them invaluable for applications demanding high performance and accuracy. As technology continues to advance, we can expect further innovations and broader adoption of ultrasonic motors in diverse industries.

It is right that we should stand by and act on our principles; but not right to hold them in obstinate blindness, or retain them when proved to be erroneous. - Michael Faraday

FLEXIBLE BATTERY TECHNOLOGY

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1. INTRODUCTION

Flexible batteries represent a promising advancement in the field of energy storage, offering a flexible and versatile solution for powering electronic devices and wearable technologies. These batteries are designed to be highly flexible, allowing them to conform to curved surfaces, bendable substrates, and irregular shapes without compromising their performance.

This abstract explores the key aspects of flexible batteries, including their design, materials, manufacturing techniques, and applications. It discusses the various types of flexible batteries, such as thin-film lithium-ion batteries, polymer-based batteries, and printed batteries, highlighting their unique characteristics and advantages. The abstract also addresses the challenges involved in developing flexible battery technologies, such as ensuring mechanical durability, optimizing energy density, and maintaining electrical performance under statin.

2. FLEXIBLE BATTERY APPLICATIONS

Furthermore, the abstract examines the potential applications of flexible batteries in a wide range of fields, including wearable electronics, medical devices, smart textiles, flexible displays, Internet of Things (IoT) devices, and electronic skin. It discusses the benefits of integrating flexible batteries into these applications, such as improved comfort, enhanced mobility, and the ability to create conformal and flexible electronic systems.

Moreover, the abstract explores the emerging trends and research directions in the field of flexible batteries, including advancements in materials science, electrode design, electrolyte formulations, and fabrication techniques. It emphasizes the importance of developing sustainable and eco-friendly battery technologies that offer high energy efficiency, long cycle life, and safe operation.

3. TYPES OF FLEXIBLE BATTERY

There are several types of flexible battery technologies being explored and developed:

3.1. Thin

Film Batteries: These batteries use thin layers of materials, such as lithium or solid-state electrolytes, to create flexible and lightweight power sources. They can be fabricated on flexible substrates, such as plastic or metal foils, using techniques like sputtering or chemical vapour deposition.

3.2. Printed Batteries

This technology involves printing battery components, including electrodes, electrolytes, and current collectors, using specialized ink formulations. It allows for the creation of batteries on flexible substrates through techniques like screen printing, inkjet printing, or roll-to-roll printing.

3.3. Fiber Batteries

These batteries are composed of flexible fibers that can be woven into textiles or integrated into clothing. They typically utilize fiber-based electrodes and electrolytes, enabling the development of wearable electronic devices with built-in power sources.

3.4. Micro

Supercapacitors: While not traditional batteries, micro-supercapacitors are energy storage devices with high power density and fast charging capabilities. They can be made flexible by using thin-film or printed technologies and have potential applications in wearable electronics and Internet of Things (IoT) devices.

4. ADVANTAGES OF FLEXIBLE BATTERY

Flexible battery technology offers several advantages, including:

4.1. Form Factor Adaptability

Flexible batteries can be shaped and integrated into a wide range of products, including wearables, smart textiles, curved displays, and flexible electronics, enabling innovative and ergonomic designs.

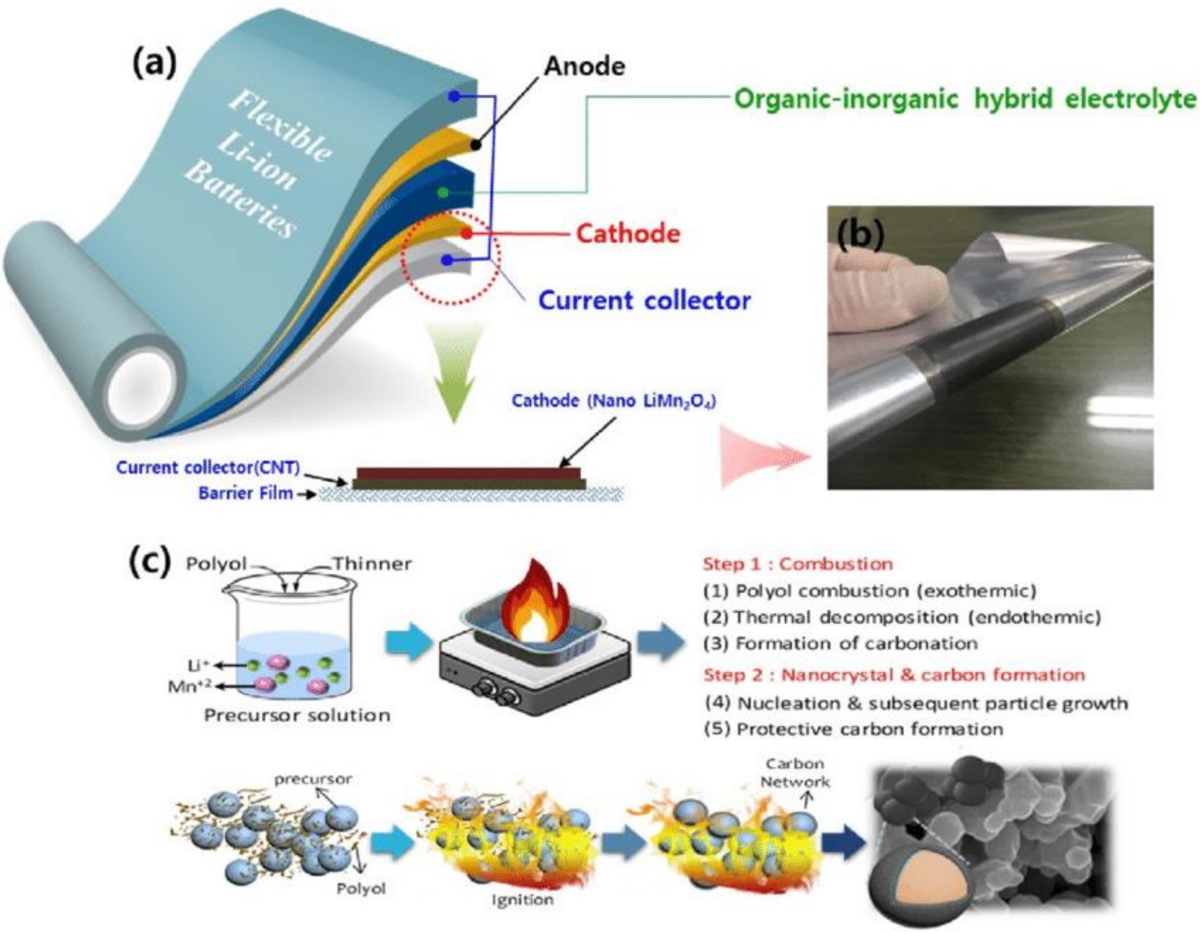
4.2. Improved Portability

The lightweight and compact nature of flexible batteries make them ideal for portable devices, as they can conform to the available space and reduce the overall weight and volume of the product.

4.3. Enhanced Durability: Flexible batteries are often designed to withstand bending, stretching, and other mechanical stresses, making them more durable than traditional rigid batteries. This durability is particularly beneficial for wearable devices that undergo frequent movement and flexing.

5. CONCLUSION

The flexibility of these batteries opens up new possibilities for the development of novel technologies and applications, such as flexible electronic skins, rollable displays, implantable medical devices, and smart packaging. While flexible battery technology is still being refined and improved, it holds great promise for the future of portable and wearable electronics, enabling the development of more comfortable, versatile, and innovative devices.



IMPORTANCE OF RENEWABLE ENERGY

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1. INTRODUCTION

Renewable energy is of paramount importance for several reasons: Renewable energy represents any energy source that can be harvested from naturally available resources and that is constantly replenished by natural processes occurring on a cycle. This energy is available in technically unlimited quantities, unlike fossil and nuclear fuels, which have a finite stock. What is most important about renewable energies is that since the energy generation is obtained by harvesting electricity or heat from a naturally occurring process, then there is no contamination for the environment and no toxic gasses are released to the atmosphere. This is the main reason why renewable energy is important to the environment.

2. IMPORTANCE OF RENEWABLE ENERGY

2. 1. Mitigating Climate Change

The use of renewable energy significantly reduces greenhouse gas emissions, helping combat climate change. By transitioning away from fossil fuels, we can limit global warming and its devastating effects on the environment.

2.2. Environmental Preservation

Renewable energy sources have minimal environmental impact compared to fossil fuels. They reduce air and water pollution, protect ecosystems, and conserve natural habitats, preserving biodiversity and ecological balance.

2.3. Energy Security

Unlike finite fossil fuel reserves, renewable energy sources like sunlight, wind, and water are inexhaustible. Investing in renewables enhances energy security, ensuring a stable energy supply even as fossil fuel resources dwindle.

2.4. Economic Growth

The renewable energy sector creates jobs, stimulates economic growth, and attracts investments. By fostering innovation and technological advancements, it boosts local economies and contributes to national GDP.

2.5. Public Health

By reducing air pollution and minimizing harmful emissions, renewable energy improves public health. Fewer pollutants mean fewer respiratory diseases, lower healthcare costs, and an overall healthier population.

2.6. Global Energy Access

Renewable energy technologies can provide electricity to remote or underserved regions, expanding energy access globally. Solar panels and wind turbines can be deployed in off-grid areas, bringing power to communities that previously lacked access to electricity.

2.7. Resource Conservation

Renewable energy helps conserve valuable natural resources. It reduces the need for extensive mining and drilling operations, preserving landscapes and ecosystems. Additionally, it decreases water usage, an essential consideration in water-scarce regions.

2.8. Technological Advancements

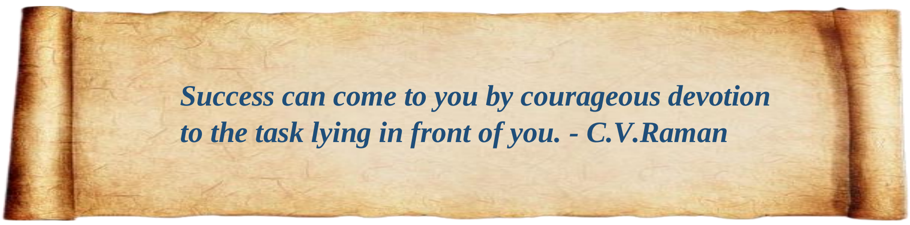
Continued investment in renewable energy drives innovation. Breakthroughs in solar, wind, and energy storage technologies benefit not only the energy sector but also lead to advancements in other fields.

2.9. Resilience to Energy Shocks

Diversifying the energy mix with renewables makes economies more resilient to energy price fluctuations and supply disruptions. This diversification ensures stability in the face of geopolitical tensions or natural disasters affecting fossil fuel supplies.

2.10. Global Leadership

Countries investing in renewable energy demonstrate leadership in the fight against climate change. They set an example for others, encouraging international collaboration and accelerating the global transition to sustainable energy practices. In summary, the importance of renewable energy lies in its ability to address climate change, preserve the environment, enhance energy security, drive economic growth, improve public health, promote global energy access, conserve resources, foster technological innovation, enhance resilience, and establish global leadership in sustainable development.



JELLY FISH: A SOURCE OF ELECRICITY

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1. INTRODUCTION

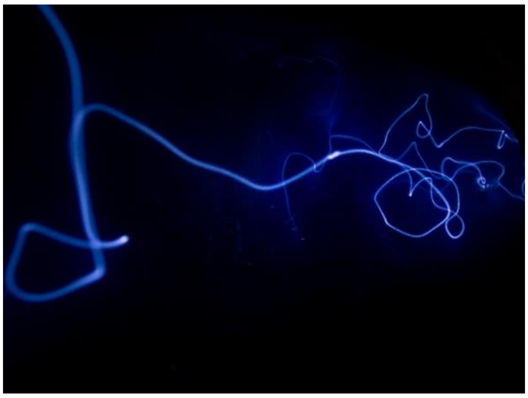
Jellyfish are found in every ocean, from the surface to the deep sea. A few jelly fish inhabit freshwater. Large, often colourful, jellyfish are common in costal zones worldwide. Jellyfish have roamed the seas for at least 500 million years, and possibly 700 million years or more, making them the oldest multi-organ animal. Jellyfish bloom formation is a complex process that depends on ocean currents, nutrients, sunshine, temperature, season, prey, availability, and reduced predation and oxygen concentrations.

2. ELECTRICITY FROM JELLYFISH

Ocean currents tend to congregate jellyfish into large swarms or "blooms", consisting of hundreds or thousands of individuals. Blooms can also result from unusually high populations in some year. Jelly fish are better able to survive in nutrient rich, oxygen- poor water than competitors, and thus can feast on plankton without competition. Jellyfish may also benefit from saltier waters, as saltier waters contain more iodine, which is necessary for polyps to turn into jellyfish. Rising sea temperatures caused by climate change may also contribute to jellyfish blooms, because many species of jellyfish are relatively better able to survive in warmer waters. Here the jellyfish has a vitamin called Green fluorescent protein "Aequo-reavictoria" jellyfish harbours a specific protein called Fluorescent Protein (GFP) that fluoresces after absorbing UV radiation. This fluorescence reveals to us that this protein does transform energy and re emits it after absorbing energy from UV radiation. If an efficient design is created, more colours of fluorescing proteins will be able to be incorporated, and thus further increase the efficiency of the dye- sensitized solar cell by expanding the range of spectra that can be absorbed by the cell and transformed into electricity.

3. CONCLUSION

Already there are designs of dye- sensitized solar cells that include many colours of dyes together in one array. It mostly finds in artic and Antarctic regions where there is no sun light. So we find fire fly which gives sunlight to produce energy.



IMPORTANCE OF E-VEHICLE

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1. INTRODUCTION

An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator). EVs include but are not limited to road and rail vehicles, and broadly can also include electric boat and underwater vessels (submersibles, and technically also diesel- and turbo-electric submarines), electric aircraft and electric spacecraft. Electric road vehicles include electric passenger cars, electric buses, electric trucks and personal transporters such as electric buggy, electric tricycles, electric bicycles and electric motorcycles/scooters.

2. IMPORTANCE OF E-VEHICLES

Electric vehicles (EVs) are important for several reasons.

2.1. Environmental Impact

EVs produce zero tailpipe emissions, reducing air pollution and combating climate change. They contribute to cleaner air and help decrease greenhouse gas emissions.

2.2. Energy Efficiency

EVs are more energy-efficient than traditional internal combustion engine vehicles. They use electricity more effectively, leading to reduced overall energy consumption.

2.3. Reduction in Fossil Fuel Dependency

By reducing the reliance on fossil fuels, EVs contribute to energy security. This is especially important considering the finite nature of fossil fuel resources.

2.4. Technological Advancement

EVs drive innovation in battery technology, electric motors, and charging infrastructure. Advancements in these areas have applications beyond just transportation, benefiting various industries.

2.5. Economic Benefits

The EV industry creates jobs in manufacturing, research, development, and maintenance of

EV-related technologies. It also fosters the growth of related industries, such as renewable energy and battery manufacturing.

2.6. Reduced Noise Pollution

EVs are generally quieter than traditional vehicles, leading to reduced noise pollution in urban areas.

2.7. Promotion of Renewable Energy

EVs can be charged using electricity from renewable sources like solar and wind power, promoting the use of clean energy.

2.8. Government Incentives

Many governments offer incentives for EV adoption, such as tax credits, rebates, and access to carpool lanes, encouraging more people to choose electric vehicles.

2.9. Improved Public Health

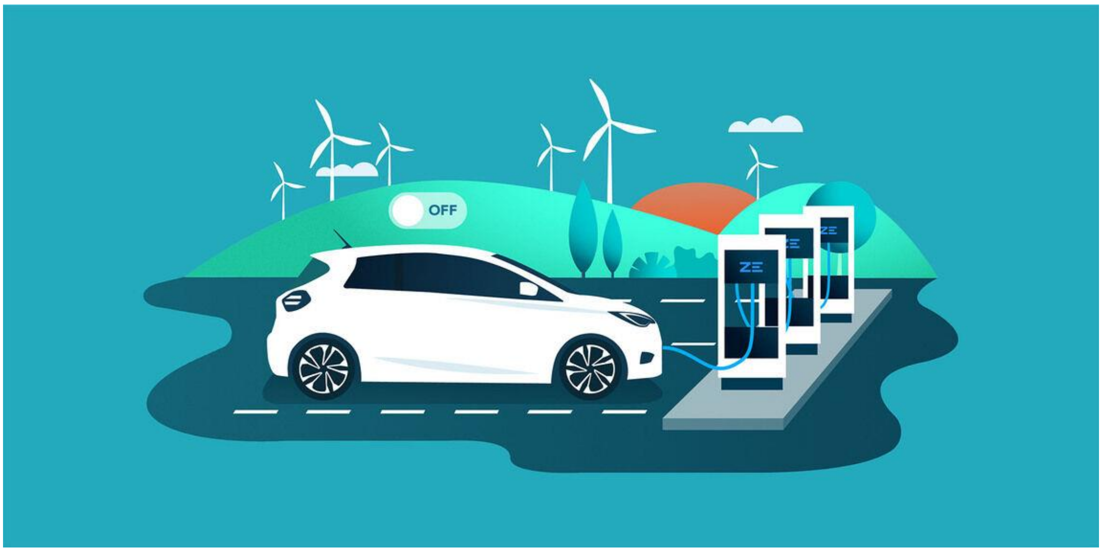
By reducing air pollutants, EVs contribute to improved public health, reducing the incidence of respiratory diseases and related healthcare costs.

2.10. Smart Grid Integration

EVs can be integrated into smart grid systems, allowing for better management of electricity supply and demand, leading to a more stable and efficient energy grid. Overall, the widespread adoption of electric vehicles plays a crucial role in creating a sustainable and environmentally friendly future.

3. CONCLUSION

Together with other emerging automotive technologies such as autonomous driving, connected vehicles and shared mobility, EVs form a future vision of transportation called Connected, Autonomous, and Shared and Electric (CASE) mobility.



Culture makes the whole world our dwelling place; our palace in which we take our ease and find ourselves at one with all things. - Satyendra Nath Bose

IMPORTANCE OF SOLAR ENERGY

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1. INTRODUCTION

Solar energy, radiation from the Sun capable of producing heat, causing chemical reactions, or generating electricity. The total amount of solar energy incident on Earth is vastly in excess of the world's current and anticipated energy requirements. If suitably harnessed, this highly diffused source has the potential to satisfy all future energy needs. In the 21st century solar energy is expected to become increasingly attractive as a renewable energy source because of its inexhaustible supply and its non-polluting character, in stark contrast to the finite fossil fuels coal, petroleum, and natural gas. Reflection and absorption of solar energy. Although some incoming sunlight is reflected by Earth's atmosphere and surface, most is absorbed by the surface, which is warmed.

2. IMPORTANCE OF SOLAR ENERGY

Solar power, harnessed from the sun's radiant energy, holds immense importance in our quest for a sustainable future. Here's why:

2.1. Renewable Energy Source

Solar power is renewable, meaning it won't run out as long as the sun exists, providing a consistent and sustainable energy source for the long term.

2.2. Environmentally Friendly

Unlike fossil fuels, solar power production does not emit greenhouse gases or pollutants, reducing air pollution, mitigating climate change, and preserving our environment.

2.3. Energy Independence

Solar power reduces dependence on finite fossil fuels, promoting energy independence for nations and decreasing reliance on imports, thereby enhancing energy security.

2.4. Economic Benefits

The solar industry creates jobs and stimulates economic growth. As technology advances,

solar power becomes more affordable, making it accessible to a broader population and fostering economic development.

2.5. Versatility

Solar panels can be installed on various scales, from individual homes to large-scale power plants. This versatility makes solar power adaptable to different energy needs, from rural electrification to urban energy demands.

2.6. Low Operating Costs

Once solar panels are installed, their operational and maintenance costs are relatively low. This cost-effectiveness makes solar power an attractive option for both residential and commercial users.

2.7. Technological Advancements

Ongoing research and innovations in solar technology are improving efficiency and storage capabilities. Breakthroughs in materials and design continue to enhance the performance of solar cells, making them more efficient and affordable.

2.8. Grid Stability

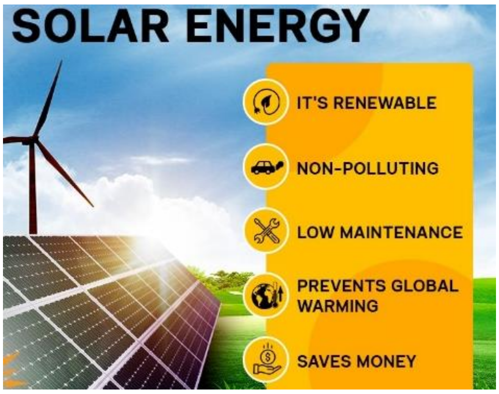
Distributed solar power systems, when integrated with smart grids and energy storage solutions, enhance grid stability by providing a constant source of energy and balancing supply and demand fluctuations.

2.9. Climate Change Mitigation

Solar power plays a significant role in mitigating climate change by reducing the carbon footprint. By transitioning to clean energy sources like solar power, we can decrease global warming and its associated impacts.

2.10. Educational and Research Opportunities

The pursuit of solar power opens avenues for education, research, and innovation. It encourages learning in fields like engineering, materials science, and environmental studies, fostering a culture of scientific progress and discovery. In summary, solar power's importance lies in its ability to provide clean, sustainable, and accessible energy, driving economic growth, enhancing energy security, and combating climate change. As we invest in solar technology and infrastructure, we move closer to a more sustainable and environmentally responsible energy future.



3. CONCLUSION

The Sun is an extremely powerful energy source, and sunlight is by far the largest source of energy received by Earth, but its intensity at Earth's surface is actually quite low. This is essentially because of the enormous radial spreading of radiation from the distant Sun. A relatively minor additional loss is due to Earth's atmosphere and clouds, which absorb or scatter as much as 54 percent of the incoming sunlight. The sunlight that reaches the ground consists of nearly 50 percent visible light, 45 percent infrared radiation, and smaller amounts of ultraviolet and other forms of electromagnetic radiation.

I dreamt a dream that, God willing, a time would come when she too would contribute her quota. Half-a-century has since then rolled by. My dream I have now the gratification of finding fairly materialized. A new era has evidently dawned upon India. - Prafulla Chandra Ray

PULSATING LIFE: THE ELECTRICAL SYMPHONY OF PACEMAKERS AND THE LIFESAVING LEGACY OF PACEMAKER INNOVATION

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1. INTRODUCTION:

In the eternal ballet of existence, our heart is the steadfast drummer, setting the tempo for our body's vibrant performance. Occasionally, however, this rhythm falters, necessitating the intervention of a technological savior: the pacemaker. This exploration reveals the journey of pacemakers from inception to modern marvel, examining the science that powers them and the lives irrevocably changed by their beat.

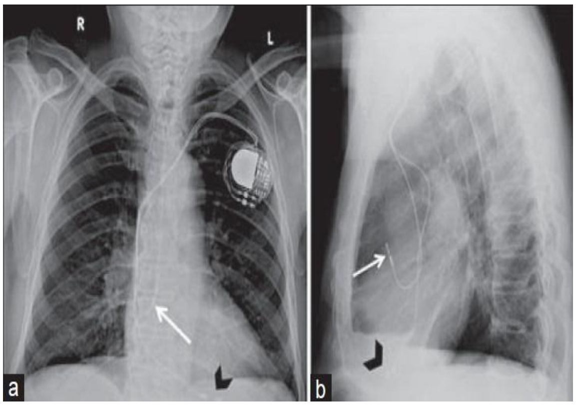
2. WHEN HEARTS SKIP A BEAT

Embarking on this exploration, we recognize a critical reality—the heart's rhythm can falter, jeopardized by its own electrical system. Set against early medical milestones of the 20th century, the pacemaker's story unfolds. We follow Earl Bakken and other visionary pioneers as they forge a path to reclaim the heart's rhythmic harmony.

3. INVENTER

Wilson Greatbatch, an American electrical engineer, invented the first implantable cardiac pacemaker in 1958. He also invented the batteries for the pacemaker. Greatbatch brought the pacemaker to the animal lab at the hospital on May 7, 1958.

4. ENGINEERING THE PULSE



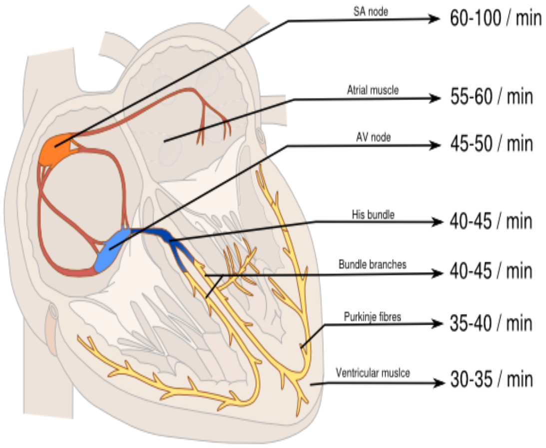
We delve into the essence of pacemaker technology and its electrical foundations. Through expert discourse and vivid illustrations, the mechanics behind these devices are demystified, unveiling how they synchronize with the natural cadence of our hearts.

5. THE INNER WORKINGS

We narrow our focus to the pacemaker's vital elements, from its pulse-generating core to the leads that intertwine with cardiac tissue. The narrative spotlights the fusion of material innovation and engineering precision, underscored by heartfelt accounts from patients whose lives have been reclaimed by these devices.

6. THE ENERGY OF EXISTENCE

In the realm of electronics, power is paramount, and pacemakers are no exception. We cast a light on the progression from initial battery designs to today's advanced power-efficient systems, examining how these devices harness energy within the body's constraints, and peering into the future of eco-friendly energy solutions.



7. TUNING INTO THE HEART'S RHYTHMS

Highlighting state-of-the-art sensing technology, we illustrate how contemporary pacemakers are finely tuned to the heart's varying demands. Interactive simulations and specialist commentary unravel the sophisticated algorithms and responsive controls that tailor these devices to individual physiological needs.

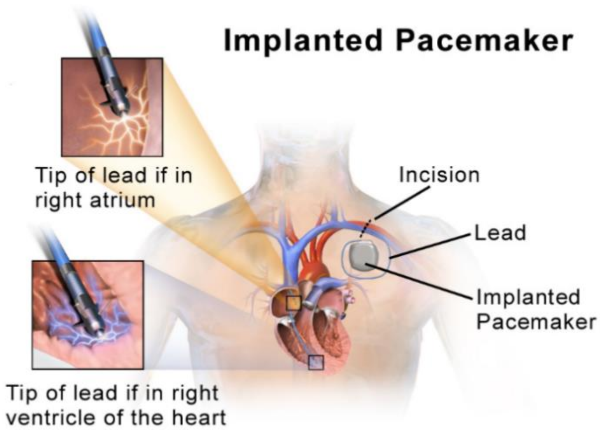
8. A WEB OF WELLNESS

Connectivity has transformed pacemaker monitoring and management. We investigate how wireless communication has paved the way for remote health tracking and intervention, while also considering the ethical implications of data privacy and the promising horizon of telehealth and interconnected medical care.

9. THE HUMAN TOUCH

We culminate our exploration by measuring the ultimate yardstick of progress—the enhancement of human health. Through touching anecdotes and reflections from individuals revitalized by pacemakers, we celebrate the tangible fruits of electrical engineering in the domain of health, culminating in an ode to the lives sustained by these extraordinary inventions.

10. HOW DOES ELECTRICITY WORK IN A PACEMAKER?



Title: Harnessing Electricity for Cardiovascular Harmony: A Comprehensive Exploration of Pacemaker Functionality.

The human heart, with its rhythmic pulsations, is a marvel of biological engineering. Yet, for those with disruptions in their heart's natural electrical system, the intervention of a pacemaker becomes a lifeline. This comprehensive exploration delves into the intricate workings of pacemakers, devices that utilize the power of electricity to regulate cardiac activity. From the power source to the delivery of precise electrical impulses, we embark on a journey through the fascinating realm of pacemaker functionality, examining the components, algorithms, and technologies that contribute to maintaining the delicate balance of the human heartbeat.

11. ANATOMY OF A PACEMAKER

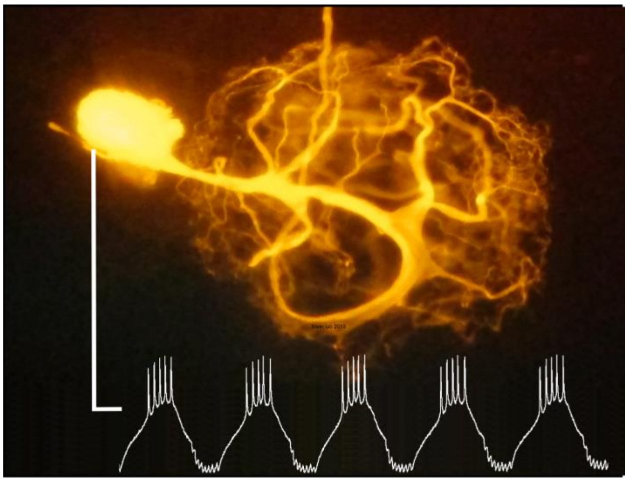
At the heart of every pacemaker lies a complex system designed to mimic and regulate the natural electrical impulses that govern the heartbeat. The central component, the pulse generator, houses the necessary electronics and power source. This section provides an in-depth look at the pulse generator's structure, emphasizing its role as the brain of the pacemaker.

12. POWERING THE PULSE

The heartbeat of a pacemaker is sustained by a reliable power source. Lithium batteries, chosen for their longevity and compactness, are the lifeblood of modern pacemakers. This section explores the evolution of battery technology within pacemakers, from early designs to the sophisticated power solutions that enable these devices to function autonomously within the human body.

13. CONNECTING TO THE HEART

Critical to a pacemaker's functionality are the leads, or electrodes, which establish a communication link between the pulse generator and the heart muscle. This section navigates the journey of leads from their entry point in the veins to their strategic placement within the heart chambers. It sheds light on the materials used, the challenges of lead placement, and the importance of secure and reliable connections.

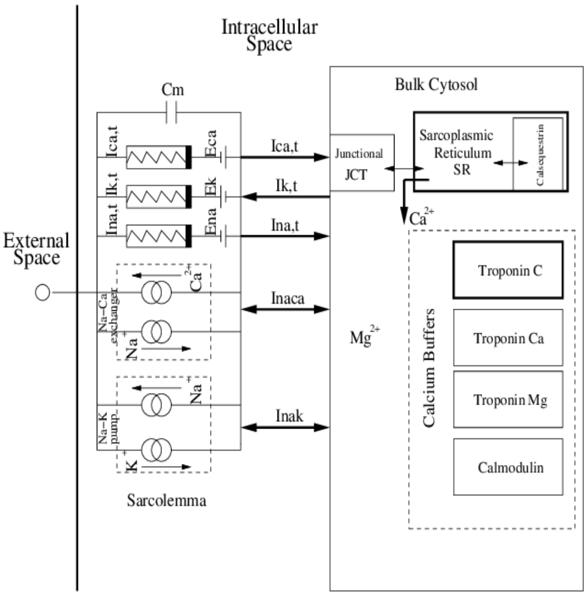


14. SENSING THE RHYTHM

The success of a pacemaker lies in its ability to perceive and interpret the heart's natural electrical signals. At the tip of the leads, sensors act as vigilant observers, continuously monitoring the heart's intrinsic activity. This section delves into the science behind these sensors, examining their design, functionality, and the pivotal role they play in ensuring the pacemaker responds accurately to the heart's needs.

15. SIGNAL PROCESSING ALGORITHMS

In the realm of pacemakers, electrical impulses are not merely delivered; they are orchestrated. Signal processing algorithms form the intelligence behind the device, analyzing the data received from sensors to make informed decisions. This section unravels the complexity of these algorithms, exploring how they distinguish normal rhythms from abnormalities, ensuring the precise and timely delivery of electrical stimuli when needed.



16. DECISION-MAKING AND PACING

As the pacemaker's algorithms analyze incoming data, they make critical decisions about when and how to intervene. This section examines the decision-making process, detailing how the pacemaker distinguishes between the heart's natural rhythm and irregularities. When intervention is necessary, the pacemaker delivers controlled electrical impulses to stimulate the heart muscle, initiating a heartbeat. The intricacies of this pacing process, from rate modulation to adaptive algorithms, are explored in detail.

17. MODES OF OPERATION

Pacemakers operate in various modes to adapt to the unique needs of individual patients. This section elucidates the distinctions between demand pacing, where the pacemaker intervenes only when the heart's natural rhythm falls below a certain threshold, and fixed-rate pacing, where the pacemaker maintains a constant rhythm irrespective of intrinsic cardiac activity. The customization of these modes to suit different clinical scenarios is emphasized.

18. CUSTOMIZATION AND ADJUSTABILITY

The versatility of pacemakers extends beyond their initial implantation. This section discusses the adjustable parameters of pacemakers, highlighting how healthcare professionals can fine-tune settings such as pacing rate and sensitivity based on individual patient requirements. The ability to personalize the pacemaker's function ensures optimal performance and responsiveness to the unique physiological characteristics of each patient.

19. WIRELESS CONNECTIVITY AND REMOTE MONITORING

In the era of digital health, pacemakers have embraced wireless connectivity and remote monitoring capabilities. This section explores how these technologies enable healthcare providers to assess the pacemaker's performance without the need for frequent in-person visits. The efficiency gains, data security considerations, and the potential for timely intervention are examined in the context of modern pacemaker innovations.

21. ADVANCEMENTS IN ELECTRICAL ENGINEERING

The landscape of pacemaker technology is continually evolving, driven by advancements in electrical engineering. This section provides insights into cutting-edge technologies such as artificial intelligence and machine learning, which are being integrated into pacemaker systems to enhance adaptability and responsiveness. Additionally, the concept of sensor fusion, combining data from various sensors for a more comprehensive understanding of the patient's cardiac activity, is explored.

22. HOW CAN WE MAKE A PACEMAKER MORE EFFICIENT?

22.1. Power Consumption Optimization

Energy-Efficient Components: Utilize low-power electronics to reduce overall energy consumption. Energy Harvesting: Integrate technologies like piezoelectric materials for supplementary power.

22.2. Battery Technology Advancements

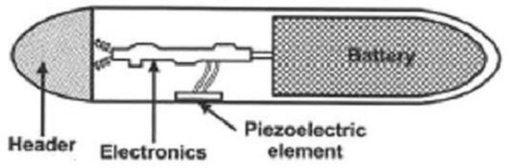
Longer Life Batteries Implement advancements to extend pacemaker battery lifespan.

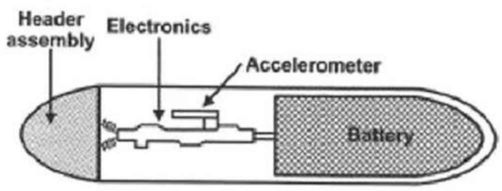
Miniaturization: Develop compact batteries without compromising energy storage.

22.3. Smart Power Management

Adaptive Power Modes: Implement algorithms adjusting power based on patient activity. Sleep Modes: Integrate intelligent sleep modes during inactivity to save energy.

22.4. Advanced Sensing and Signal Processing





Customizable Sensing: Develop adaptable sensors to reduce unnecessary pacing. Signal Processing Algorithms: Continuously enhance algorithms for accurate event detection, minimizing unnecessary pacing.

22.5. Wireless Connectivity and Remote Monitoring

Efficient Data Transmission: Optimize wireless protocols for reduced energy consumption. Intermittent Monitoring: Implement periodic remote monitoring to conserve power.

22.6. Biocompatible Materials

Longer Lasting Materials: Research materials with extended lifespan, reducing device replacements. Reduced Corrosion: Develop corrosion-resistant materials for consistent performance.

22.7. Personalized Medicine Approaches

Patient-Specific Programming: Tailor settings to individual needs based on real-time data. Adaptive Algorithms: Explore algorithms adapting pacing based on unique cardiac patterns.

22.8. Integration with Emerging Technologies

AI and Machine Learning: Integrate AI for enhanced adaptation to physiological changes. Sensor Fusion combines data from various sensors for precise and efficient pacing.

22.9. Research and Development

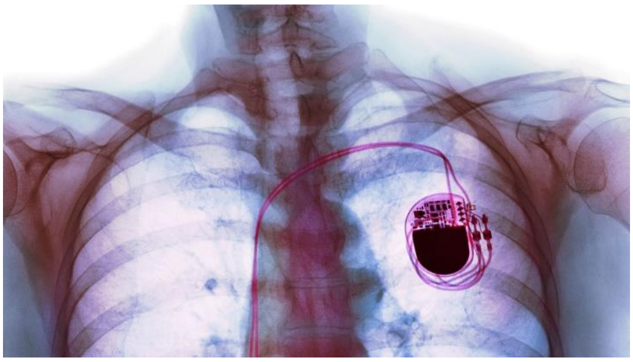
Continuous Innovation: Invest in ongoing R&D for cutting-edge advancements. Collaboration: Foster interdisciplinary collaboration for a holistic approach.

22.10. Regulatory Compliance and Safety

Efficient Testing Protocols: Develop streamlined testing to ensure safety, expediting regulatory approvals.

23. CONCLUSION

Electricity, harnessed and carefully orchestrated within the intricate design of a pacemaker, stands as a beacon of hope for individuals with disrupted cardiac rhythms. From the power source to the delivery of precision-paced electrical impulses, each component plays a vital role in maintaining the delicate balance of the heart's symphony. As we navigate through the anatomy, algorithms, and technologies that define pacemaker functionality, we gain a profound appreciation for the intersection of electrical engineering and medical science—a collaboration that breathes life into these remarkable devices. The journey through the pulsating world of pacemakers not only unveils the complexity of their inner workings but also highlights the relentless pursuit of innovation aimed at improving the quality of life for those in need. "Rhythms Restored: The Heartbeat's Ingenious Ally" guides viewers on an enthralling voyage across the ages, showcasing the intersection of ingenuity in electrical engineering with the art of healing. From nascent experimental devices to today's interconnected systems, pacemakers stand as monuments to human creativity and empathy. As we contemplate their evolution from past to future, we gain a profound respect for the electric spark that revives and maintains our most vital rhythm—the heartbeat.



My success will not depend on what A or B thinks of me. My success will be what I make of my work. I do have this one purpose — increasing the intensity of my consciousness of life. Physics is my line. - Homi J. Bhabha

ENERGY EFFICIENT MOTORS (EEM)

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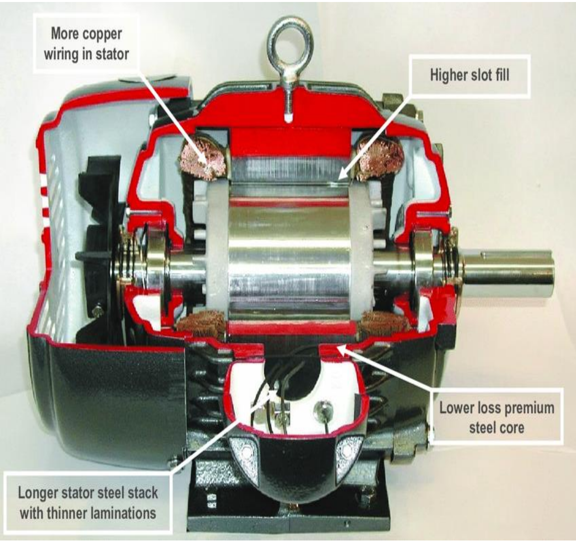
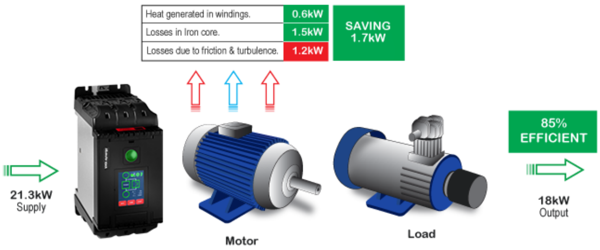
1. INTRODUCTION

A large fraction of electrical energy consumed in many facilities is used to run electric motors. Nationally, motor driven systems account for about 57% of all electrical energy use. The electric motor manufacturers are seeking methods for improving the motor efficiencies, which resulted in a new generation of electric motors that are known as energy efficient motors. This paper deals with energy conservation by installing energy efficient motor (EEM) instead of standard efficiency motor.



2. ENERGY EFFICIENT MOTORS (EEM)

- It produces same shaft output power but uses less electrical input power than a standard efficiency motor.
- Standard motor generally competes on price, not efficiency, but EEM competes on efficiency, not price.
- In Energy efficient motors both single phase and three- phase motors are easily available.
- EEM are higher quality motors with longer warranty and life span (about 20 years)



3. HOW ENERGY EFFICIENT MOTOR DIFFER FROM STANDARD MOTOR?

- Higher quality and thinner steel laminations in the stator
- More copper in the windings
- Smaller air gap between the rotor and stator
- Reduced fan losses
- Closer machining tolerances
- Generally, they cost 15 to 30 percent more than standard motors, depending on the specific motor, manufacturer, and market competition.

4. BENEFITS OF IMPLEMENTING EEM SYSTEMS

- Electricity savings potential
- Environmental benefits
- Micro & Macro economic benefits
- High efficiency motor design
- Improved steel
- Thinner laminations
- Increasing conductor's volume
- Modified slot design
- Narrowing air gap
- Improved rotor insulation
- More efficient fan design

5. MOTOR LOSSES

- **Core Loss:** represents energy required to magnetize the core material (hysteresis) and includes losses due to creation of eddy currents that flow in the core.

- **Windage and Friction Losses:** occur due to bearing friction and air resistance.
- **Stator Losses:** appear as heating due to current flow through the resistance of the wire of the stator winding. This is commonly referred to as an I^2R loss.
- **Rotor Losses:** appear as 1^2R heating in the rotor winding.
- **Stray Load Losses:** are the result of leakage fluxes induced by load currents.

6. EFFICIENCY IMPROVEMENT BY INSERTING OF SUPERCONDUCTING MATERIALS

- High temperature superconductors (HTS), which offered the advantage of cooling via liquid nitrogen instead of liquid helium.
- Complete elimination of refrigerator power consumption would only show an improvement in machine efficiency of -0.02% for a 300 MVA rating.
- More importance than the efficiency improvement is that use of a liquid nitrogen ambient would lead to reduced capital costs for the refrigeration plant and reduce the complexity of the cryogenic design.

7. ENERGY EFFICIENT MACHINE DESIGN BY PROPER SELECTION OF CORE MATERIAL

- Core loss in a machine is around 30-50% of the total losses.
- Reduction of core material thickness and stress relief annealing of the core improved machine efficiency.
- used high permeability materials as core , like high graded silicon steel
- By used thin laminate silicon core we reduce the eddy current losses.

8. POWER FACTOR IMPROVEMENT IN IM

- Installing external capacitor
- Avoid operation of equipment above its rated speed

9. APPLICATIONS

Motors are suitable for wide industrial applications like paper, cement, textiles, cranes, material handling, and machine tools and blowers etc.

10. CONCLUSION

Most of the industrial loads having motors are consuming 70% of the total electricity. So it is better to replace standard motors with energy efficient motors where ever economical, so that we can Save energy and save money.

ELECTRIC VEHICLE TECHNOLOGY

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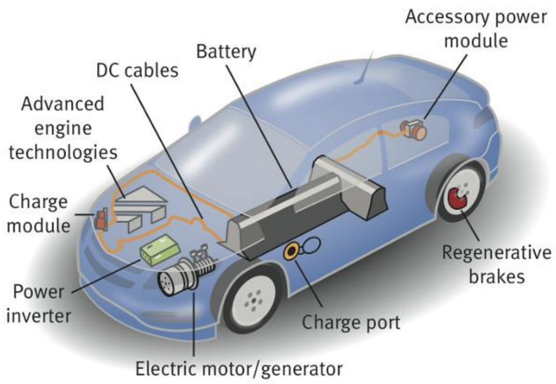
1. INTRODUCTION

Electric vehicles (EVs) represent a revolutionary development in the transportation sector, offering a cleaner and more sustainable alternative to traditional internal combustion engine (ICE) vehicles.

This technical note explores the key aspects of electric vehicle technology and its impact on the automotive industry and the environment.



2. ELECTRIC VEHICLE COMPONENTS

2.1 .Battery Technology

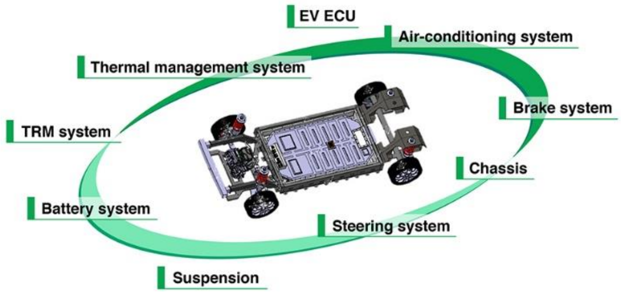
The heart of any electric vehicle is its battery pack. Lithium-ion batteries are the most commonly used in EVs, providing a high energy density. Advancements in battery technology have resulted in longer driving ranges and faster charging times. Solid-state batteries hold promise for even greater improvements in the near future.

2.2. Electric Motor

Electric vehicles utilize electric motors for propulsion. These motors are highly efficient and have instant torque, providing a smooth and responsive driving experience. Many EVs use an AC induction motor, while others employ permanent magnet motors for improved efficiency.

2.3. Power Electronics

Power electronics components, including inverters and converters, control the flow of electricity between the battery and the motor. They ensure efficient power conversion and help manage regenerative braking energy.



3. CHARGING INFRASTRUCTURE

The availability and accessibility of charging infrastructure play a crucial role in the widespread adoption of electric vehicles. There are three main types of charging:

3.1. Level 1 (120V)

This is the slowest form of charging, typically used for home charging. It provides around 2-5 miles of range per hour of charging.

3.2. Level 2 (240V)

Commonly found at public charging stations and in homes with dedicated charging equipment, level 2 charging can add 10-60 miles of range per hour, depending on the charger's power output.

3.3. DC Fast Charging

These high-power chargers can provide 100 miles or more of range in as little as 20-30 minutes. They are essential for long-distance travel and are typically found along highways and in urban areas.

4. ENVIRONMENTAL IMPACT

Electric vehicles are often touted for their environmental benefits. By eliminating tailpipe emissions, they contribute to reduced air pollution and greenhouse gas emissions. However, it's important to consider the environmental impact of battery production and electricity generation. As the electricity grid becomes cleaner, the overall environmental benefits of EVs increase.

5. COST CONSIDERATIONS

The initial purchase price of electric vehicles is typically higher than that of traditional gasoline vehicles. However, lower operating costs, including reduced fuel and maintenance expenses, can make EVs cost-competitive over the long term. Government incentives and rebates in many countries further reduce the upfront cost.

6. ADVANCEMENTS AND FUTURE PROSPECTS

6.1 Range Improvements

Ongoing research aims to increase the energy density of batteries and extend the driving range of electric vehicles. Solid-state batteries and other emerging technologies hold great promise in this regard.

6.2. Charging Infrastructure Expansion

The growth of charging infrastructure, including ultra-fast chargers, is vital for the widespread adoption of EVs. Governments and private companies are investing heavily in this area.

6.3. Vehicle to Grid (V2G) Technology

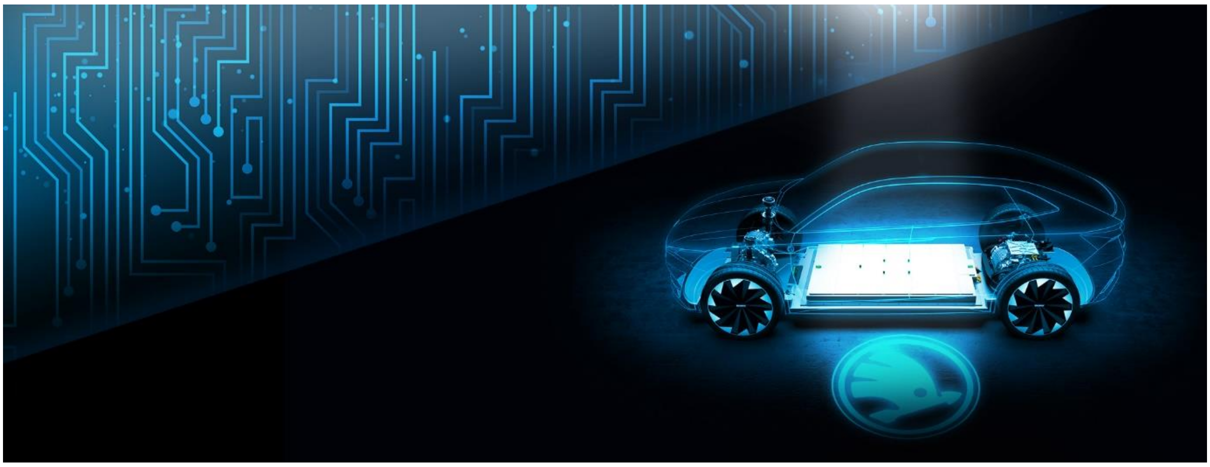
V2G systems enable electric vehicles to not only draw power from the grid but also feed excess energy back, supporting grid stability and potentially reducing energy costs for EV owners.

6.4. Autonomous Electric Vehicles

The convergence of electric and autonomous vehicle technologies may reshape the future of transportation, providing safe, efficient, and sustainable mobility solutions.

7. CONCLUSION

Electric vehicle technology is transforming the automotive industry and driving the shift toward a more sustainable and environmentally friendly mode of transportation. While challenges remain, continued advancements in battery technology, charging infrastructure, and environmental sustainability will likely accelerate the adoption of electric vehicles in the years to come. As society embraces this technology, we move closer to a future where clean and efficient transportation is the new norm.



HARNESSING THE BREEZE - BLADELESS ROOFTOP WIND ENERGY GENERATION SYSTEMS

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1. INTRODUCTION

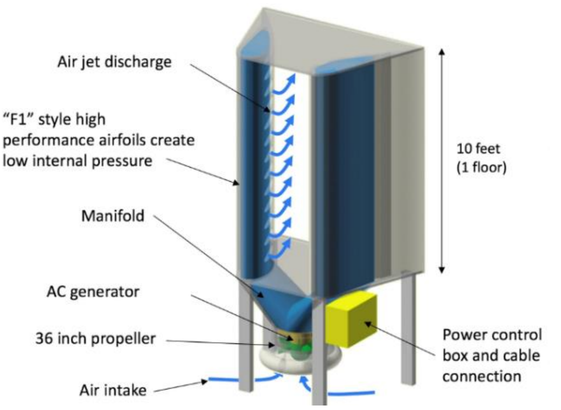
Rooftop wind energy systems without blades are becoming popular for their eco-friendly features. These systems ditch traditional spinning blades, providing a greener and more efficient energy solution. This article explores the potential of bladeless rooftop wind energy systems and their positive impact on creating a sustainable future.

2. THE BLADELESS ADVANTAGE

Bladeless wind energy systems are a departure from regular turbines. They solve common issues like noise and visual impact. Their sleek design makes them visually appealing and easily blends with different architectural settings.

3. HOW IT WORKS

Unlike regular turbines, bladeless systems use different mechanisms. Some designs use vibrating rods, while others capture wind energy through aeroelastic flutter. These designs not only capture energy better but also reduce maintenance issues associated with traditional turbine blades.



4. VIBRATING RODS

In some bladeless designs, the system incorporates vibrating rods. As the wind flows, these rods vibrate, and this vibration is then converted into electricity. It's a creative way to capture wind energy without the need for spinning blades. This design not only improves energy capture but also addresses maintenance concerns commonly linked to traditional turbine blades.

5. AEROELASTIC FLUTTER

Another mechanism involves aeroelastic flutter. In this design, a flexible structure is utilized. When the wind interacts with this structure, it induces oscillations. These oscillations are then transformed into electrical power. This approach is innovative and efficient, providing an alternative means of converting wind energy into usable electricity. Additionally, it reduces maintenance issues, offering a more sustainable and reliable solution compared to traditional turbine blades.

6. URBAN INTEGRATION

Bladeless systems are promising for urban areas. They are compact, quiet, and visually unobtrusive, making them suitable for densely populated places. Rooftops of buildings become valuable sources of clean energy, maximizing space without compromising looks.

7. EFFICIENCY AND ADAPTABILITY

Bladeless systems are competitive in efficiency compared to regular turbines. They work well in various environmental conditions and at lower wind speeds, making them suitable for different locations. This adaptability makes bladeless rooftop wind energy systems a reliable and efficient renewable energy option.

8. BENEFITS

The use of these different mechanisms in bladeless systems offers several advantages. Firstly, they enhance the capture of wind energy, making the system more efficient. Secondly, by eliminating spinning blades, maintenance concerns associated with wear and tear, lubrication, and structural stress are minimized. This not only improves the longevity of the system but also reduces the need for frequent and costly maintenance, contributing to a more reliable and sustainable energy solution.

9. CHALLENGES AND FUTURE DEVELOPMENTS

Despite their promise, challenges like scalability and cost-effectiveness exist for bladeless systems. Ongoing research aims to address these issues and improve the technology for wider use. As the technology advances, we can expect further improvements that make bladeless rooftop wind energy systems a common feature in renewable energy solutions.

10. CONCLUSION

Bladeless rooftop wind energy systems offer a significant step towards a sustainable and visually pleasing future. As we work to meet the demand for clean energy, innovations like these show how technology can harmonize with the environment. With ongoing research and development, bladeless wind energy systems may become essential contributors to our pursuit of a greener and more sustainable world.

EMPOWERING THE FUTURE: A TECHNICAL OVERVIEW OF SMART GRIDS

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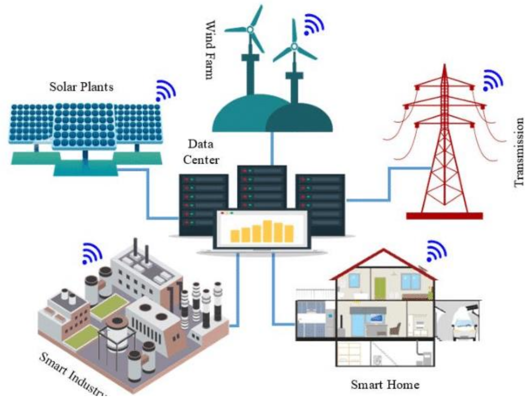
1. INTRODUCTION

This technical document delves into the intricacies of smart grids, exploring their architecture, components, and the transformative impact of digital technologies on power distribution systems. From advanced sensors to real-time analytics, discover how smart grids are shaping a more efficient, resilient, and sustainable energy landscape. Smart grids represent a paradigm shift in power distribution, leveraging digital advancements to address the challenges of conventional grids. This section provides an overview of the need for smart grids and their role in enhancing energy efficiency.

2. ARCHITECTURE OF SMART GRIDS

Explore the layered architecture of smart grids, including components such as smart meters, sensors, communication networks, and data analytics platforms. Understand how these elements work in harmony to create an intelligent and responsive energy infrastructure.



3. ADVANTAGE METERING INFRASTRUCTURE (AMI)

Delve into the details of AMI, the backbone of smart grids. Discuss the functionalities of smart meters, their communication protocols, and the data they generate, emphasizing the role of two-way communication in enabling dynamic energy management.

4. SENSOR INTEGRATION

Examine the integration of sensors across the grid, from substations to distribution lines. Understand how these sensors monitor variables like voltage, current, and temperature, providing real-time data for grid operators to optimize performance and detect anomalies.

5. COMMUNICATION NETWORK

Analyse the communication networks that facilitate seamless data exchange within smart grids. Discuss the importance of robust, secure, and low-latency networks in ensuring timely information flow between grid components.

6. DATA ANALYTICS AND CONTROL SYSTEM

Explore the role of data analytics in extracting meaningful insights from the vast amount of data generated by smart grids. Discuss control. Systems that use these insights to make real-time adjustments, optimizing energy flow and responding to grid disturbances.

7. GRID RESILIENCE AND SECURITY

Address the challenges and solutions related to the resilience and security of smart grids. Discuss strategies for safeguarding against cyber threats and ensuring the continuity of power supply in the face of unforeseen events.

8. ENVIRONMENTAL IMPACT AND SILUSTAINABILITY

Examine how smart grids contribute to sustainability goals by enabling better integration of renewable energy sources, reducing losses, and promoting energy conservation through demand-side management.

9. CASE STUDIES

Highlight real-world examples of successful smart grid implementations. Showcase instances where smart grids have demonstrated improved efficiency, reduced downtime, and enhanced overall grid performance.

10. FUTURE TRENDS AND CHALLENGES

Discuss emerging trends in smart grid technology, such as the integration of artificial intelligence, block chain, and the Internet of Things (IoT). Address potential challenges and considerations for future developments in this dynamic field.

11. CONCLUSION

Summarize key insights and emphasize the transformative potential of smart grids in shaping the future of power distribution. Conclude with reflections on the ongoing evolution of smart grid technologies and their implications for the broader energy landscape.

RAILWAY 25 KV

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1. INTRODUCTION

This electrification is ideal for railways that cover long distances or carry heavy traffic. After some experimentation before World War II in Hungary and in the Black Forest in Germany, it came into widespread use in the 1950s.

2. HISTORY

One of the reasons why it was not introduced earlier was the lack of suitable small and lightweight control and rectification equipment before the development of solid-state rectifiers and related technology. Another reason was the increased clearance distances required where it ran under bridges and in tunnels, which would have required major civil engineering in order to provide the increased clearance to live parts. Railways using older, lower-capacity direct current systems have introduced or are introducing 25 kV AC instead of 3 kV DC/1.5 kV DC for their new high-speed lines. This electrification is ideal for railways that cover long distances or carry heavy traffic. After some experimentation before World War II in Hungary and in the Black Forest in Germany, it came into widespread use in the 1950s.

3. APPLICATION

One of the reasons why it was not introduced earlier was the lack of suitable small and lightweight control and rectification equipment before the development of solid-state rectifiers and related technology. Another reason was the increased clearance distances required where it ran under bridges and in tunnels, which would have required major civil engineering in order to provide the increased clearance to live parts.

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SYNCHRONOUS ELECTRIC MOTOR

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1. INTRODUCTION

Synchronous electric motor is an AC electric motor in which, at steady state, the rotation of the shaft is synchronized with the frequency of the supply current; the rotation period is exactly equal to an integral number of AC cycles. Synchronous motors use electromagnets as the stator of the motor which create a magnetic field that rotates in time with the oscillations of the current. The rotor with permanent magnets or electromagnets turns in step with the stator field at the same rate and as a result, provides the second synchronized rotating magnet field. A synchronous motor is termed doubly fed if it is supplied with independently excited multiphase AC electromagnets on both the rotor and stator.

2. AC MOTORS

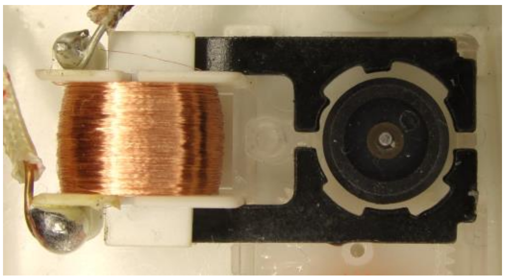
Synchronous and induction motors are the most widely used AC motors. Synchronous motors rotate at a rate locked to the line frequency since they do not rely on induction to produce the rotor's magnetic field. Induction motors require slip: the rotor must rotate at a frequency slightly slower than the AC alternations in order to induce current in the rotor. Small synchronous motors are used in timing applications such as in synchronous clocks, timers in appliances, tape recorders and precision servomechanisms in which the motor must operate at a precise speed; accuracy depends on the power line frequency, which is carefully controlled in large interconnected grid systems.

3. APPLICATIONS

Synchronous motors are available in self-excited, fractional to industrial sizes. In the fractional horsepower range, most synchronous motors are used to provide precise constant speed. These machines are commonly used in analog electric clocks, timers and related devices. Miniature Synchronous Motor is used in analog clocks. The rotor is made of permanent magnet.

4. CONCLUSION

Small synchronous motor with integral stepdown gear from a microwave oven. In typical industrial sizes, the synchronous motor provides an efficient means of converting AC energy to work (electrical efficiency above 95% is normal for larger sizes) and it can



operate at leading or unity power factor and thereby provide power-factor correction.

EMPOWERING THE FUTURE: UNRAVELING THE POTENTIAL OF PAPER BATTERIES

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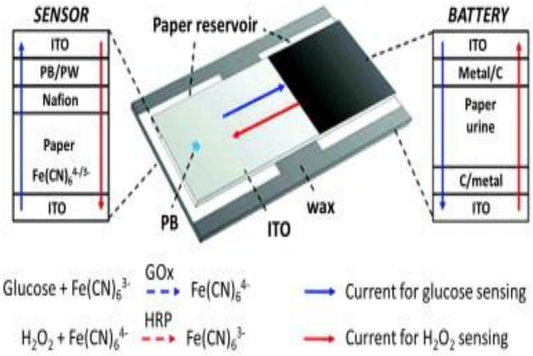
1. INTRODUCTION

In a world driven by the quest for sustainable energy solutions, paper batteries emerge as a groundbreaking innovation at the intersection of technology and eco-friendliness. This article delves into the captivating realm of paper batteries, exploring their composition, applications, and the promise they hold for a greener tomorrow. The fusion of paper and energy storage technologies has given rise to paper batteries – thin, flexible, and environmentally friendly power sources. This article embarks on a journey to unravel the layers of this eco-conscious energy solution.



2. COMPOSITION AND WORKING PRINCIPLE

Paper batteries typically consist of cellulose-based paper infused with conductive materials and nanotubes. The composition allows for flexibility while retaining the ability to conduct electricity. Delve into the intricacies of how these components work together to generate power in a clean and efficient manner.

3. APPLICATIONS ACROSS INDUSTRIES

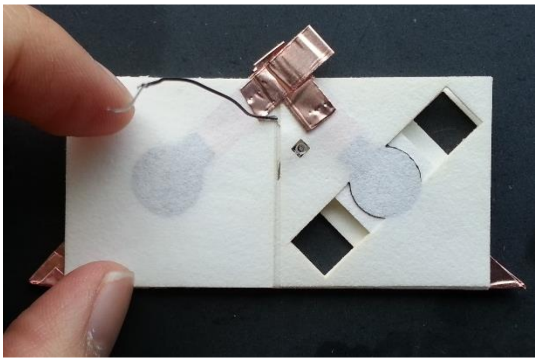
From wearable devices to medical implants, paper batteries find applications across a myriad of industries. Explore how this versatile energy source is reshaping the landscape of electronic devices, offering a sustainable alternative to traditional batteries.

4. ENVIRONMENTAL IMPACT

One of the most compelling aspects of paper batteries is their minimal environmental impact. Dive into the eco-friendly aspects of these batteries, examining their biodegradability and reduced reliance on harmful materials, in contrast to conventional batteries.

5. CHALLENGES AND FUTURE PROSPECTS

While paper batteries showcase immense potential, they are not without challenges. Investigate the hurdles researchers face in optimizing performance, scalability, and commercial viability. Moreover, peek into the future as scientists strive to overcome these obstacles and propel paper batteries into mainstream use.



6. CASE STUDIES AND SUCCESS STORIES

Highlight real-world examples where paper batteries have made a difference. From powering remote sensors in environmental monitoring to enhancing the lifespan of medical implants, these case studies offer tangible proof of the impact paper batteries can have.

7. CONCLUSION

As the demand for sustainable technologies intensifies, paper batteries stand as a beacon of innovation. This article concludes by emphasizing the transformative potential of these eco-friendly power sources and their role in shaping a cleaner, energy-efficient future.

A NEW BEGINNING FOR ELECTRIC CARS

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1. INTRODUCTION

While all the starts and stops of the electric vehicle industry in the second half of the 20th century helped show the world the promise of the technology, the true revival of the electric vehicle didn't happen until around the start of the 21st century. Depending on whom you ask, it was one of two events that sparked the interest we see today in electric vehicles.

2. HISTORY OF ELECTRIC CARS

The first turning point many have suggested was the introduction of the Toyota Prius. Released in Japan in 1997, the Prius became the world's first mass-produced hybrid electric vehicle. In 2000, the Prius was released worldwide, and it became an instant success with celebrities, helping to raise the profile of the car. To make the Prius a reality, Toyota used a nickel metal hydride battery -- a technology that was supported by the Energy Department's research. Since then, rising gasoline prices and growing concern about carbon pollution have helped make the Prius the best-selling hybrid worldwide during the past decade. Before the Prius could be introduced in the U.S., Honda released the Insight hybrid in 1999, making it the first hybrid sold in the U.S. since the early 1900s.

3. FUTURE DEVELOPMENT

The other event that helped reshape electric vehicles was the announcement in 2006 that a small Silicon Valley start-up, Tesla Motors, would start producing a luxury electric sports car that could go more than 200 miles on a single charge. In 2010, Tesla received at $465 million loan from the Department of Energy's Loan Programs Office, a loan that Tesla repaid a full nine years early to establish a manufacturing facility in California. In the short time since then, Tesla has won wide acclaim for its cars and has become the largest auto industry employer in California. Tesla's announcement and subsequent success spurred many big automakers to accelerate work on their own electric vehicles. In late 2010, the Chevy Volt and the Nissan LEAF were released in the U.S. market. The first commercially available plug-in hybrid, the Volt has a gasoline engine that supplements its electric drive once the battery is depleted, allowing consumers to drive on electric for most trips and gasoline to extend the vehicle's range. In comparison, the LEAF is an all-electric vehicle (often called a battery-electric vehicle, an electric vehicle or just an EV for short), meaning it is only powered by an electric motor. Over the next few years, other automakers began rolling out electric vehicles in the U.S.; yet, consumers were still faced with one of the early problems of the electric vehicle where to charge their vehicles on the go. Through the Recovery Act, the Energy Department invested more than $115 million to help build a nation-wide charging infrastructure, installing more than 18,000 residential, commercial and public chargers across the country. Automakers and other private businesses also installed their own chargers at key locations in the U.S., bringing today's total of public electric vehicle chargers to more than 8,000 different locations with more than 20,000 charging outlets.

At the same time, new battery technology supported by the Energy Department's Vehicle Technologies Office began hitting the market, helping to improve a plug-in electric vehicle's range. In addition to the battery technology in nearly all of the first generation hybrids, the Department's research also helped develop the lithium-ion battery technology used in the Volt. More recently, the Department's investment in battery research and development has helped cut electric vehicle battery costs by 50 percent in the last four years, while simultaneously improving the vehicle batteries' performance (meaning their power, energy and durability). This in turn has helped lower the costs of electric vehicles, making them more affordable for consumers.

4. CONCLUSION

Consumers now have more choices than ever when it comes to buying an electric vehicle. Today, there are 23 plug-in electric and 36 hybrid models available in a variety of sizes from the two-passenger Smart ED to the midsized Ford C-Max Energi to the BMW i3 luxury SUV. As gasoline prices continue to rise and the prices on electric vehicles continue to drop, electric vehicles are gaining in popularity with more than 234,000 plug-in electric vehicles and 3.3 million hybrids on the road in the U.S. today.

THE LATEST TECHNOLOGY IN THE NEXT GEN. BLDC (BRUSHLESS DC MOTOR) MOTOR CONTROL DESIGN

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1. INTRODUCTION

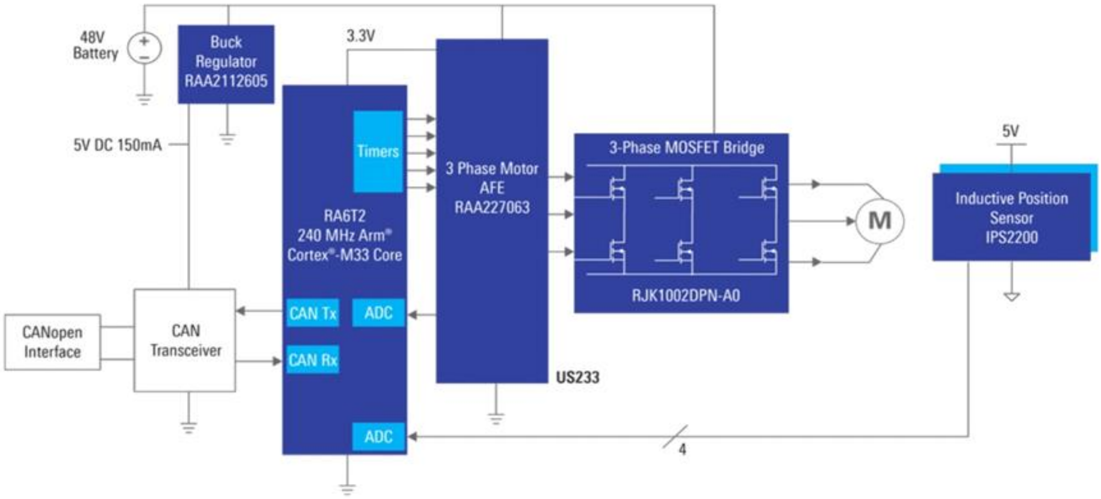
Motors are built into everything from simple home appliances to advanced industrial equipment in factories requiring multiple motors. The speed of technological innovation continues to advance and motors are growing more diversified according to the application. Simple DC motors can be controlled by switching while electronic control is performed by the MCU or MPU to adjust speed, torque, and in some cases, accurate position. In addition, as energy-saving regulations are adopted in each region, companies are having to develop products with the aim of realizing highly efficient motor control while consuming less power.

2. HISTORY OF BRUSSHLESS MOTORS

Due to the coronavirus pandemic, the need for home appliances has increased and changed now that more people are working remotely and spending more time at home. The demand for the replacement of air conditioners is on the rise, and in place of traveling, the sales of kitchen appliances have increased, especially in the high-end machine categories. In turn, motor equipment developers face the challenge of achieving early market launch of new features at a low cost. Renesas has supported this market by developing MCUs and various solutions for motor control for many years. Because we know manufacturers require complete systems with devices designed to help achieve these demanding design requirements, Renesas has also been creating a library of motor control reference solutions, also known as winning combinations. The latest of these is the BLDC Traction Motor Drive design.

3. NEW CONTROL METHOD

This new motor control winning combination is built around two dedicated motor control devices, the RA6T2 MCU and RAA227063 3-phase smart MOSFET driver. These two devices offer the perfect combination of processing speed and power efficiency, making them ideal for traction motors that require miniaturization, such as those used in factory transfer robots, among others. RAA227063 integrates power management to power both the driver and RA6T2 directly from the battery, reducing the overall size of the circuit. The programmable RAA227063 allows designers to optimize the inverter power stage for different power levels by simply modifying the MOSFET and adjusting the slew rate, dead time, and gate drive with software. RA6T2 is equipped with abundant interface options, such as serial communication, SPI, I2C, and CAN FD and can communicate with the host system as well as provide synchronous operation with other motors.



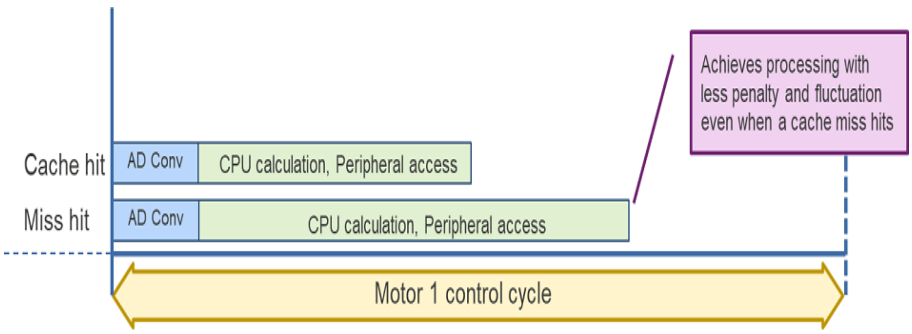
The RA6T2 MCU is the second product in the RA family of application-specific standard products (ASSPs) for motor control that combines the Arm® Cortex® M33 CPU, high-speed flash memory, and peripheral functions required for motor control systems.

4. MAJOR FEATURES

A major feature of RA6T2 is the high real-time performance achieved by its CPU and flash memory operating at 240 MHz. Cache memory is effective for high-speed CPUs, but in the case of low-speed flash access, performance is degraded due to cache miss-hit penalty. For sequential programs, the prefetch feature and cache provide stable peak performance. Generally, motor control programs generate branch instructions and interrupts so access to flash memory is unavoidable as a miss-hit penalty. Even if a cache miss-hit occurs in RA6T2 and the flash memory is accessed, the performance

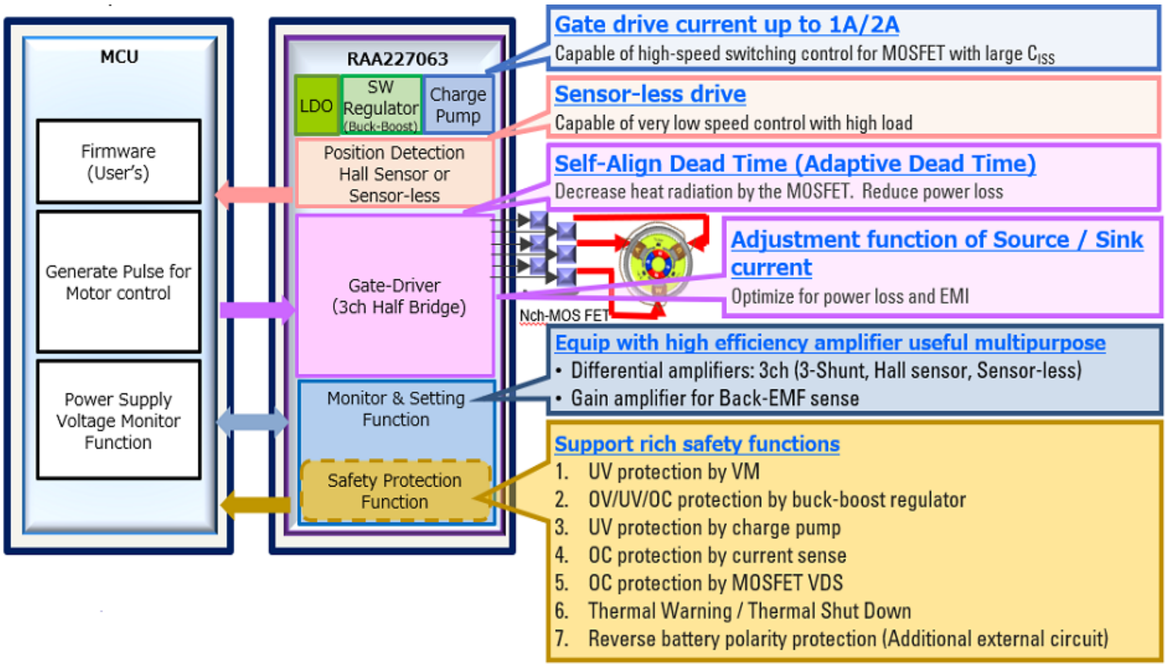
is maintained due to its high speed. This is a great advantage for motor applications where real-time performance is paramount.

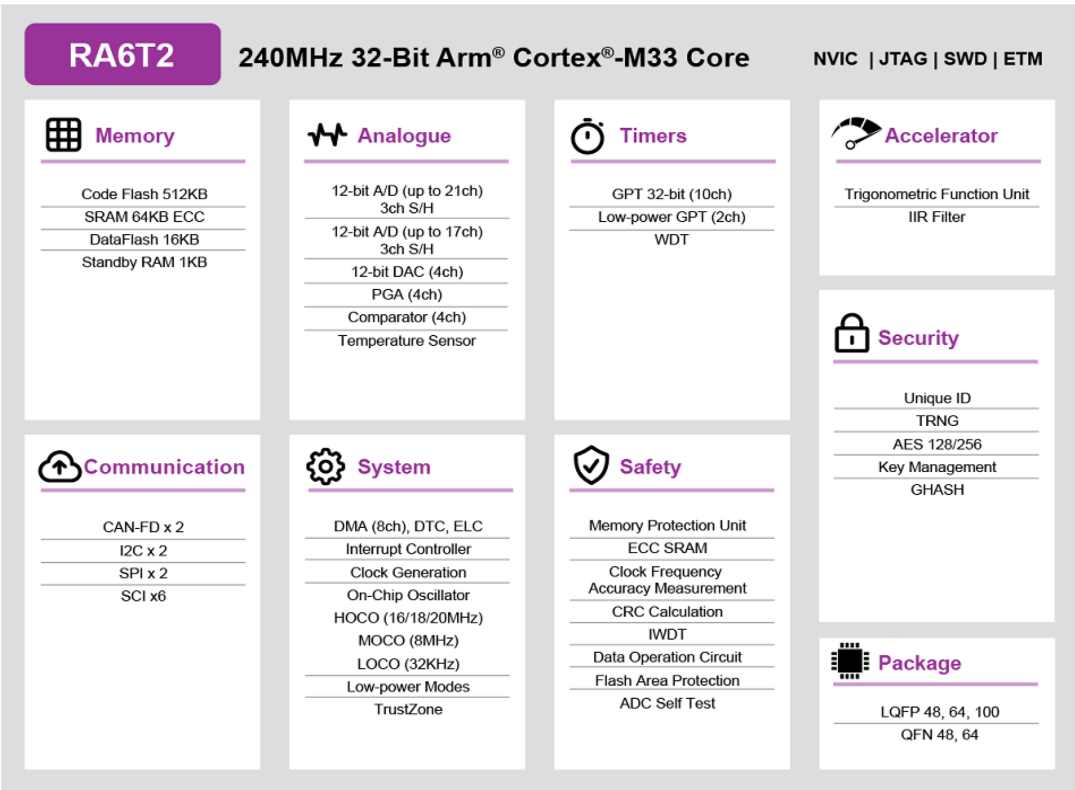
The RAA227063 is a high-precision, high-efficien+cy smart 3-phase driver that simplifies BLDC motor design by driving a variety of



motor configurations and motor control algorithms without making hardware changes. It pairs easily with any MCU so customers can scale the MCU to their application requirements. Integrated analog power components save board space, lower BOM cost, and allow for easy tuning.

RAA227063 integrates three half-bridge smart MOSFET drivers that are capable of driving up to three N-channel MOSFET bridges and supports bridge voltages from 4.5V to 60V.





5. CONCLUSION

Each gate driver supports up to 1A source and 2A sink peak drive current with programmable drive strength control. Adjustable and adaptive dead times are implemented to ensure robustness and flexibility. The active gate holding mechanism prevents a Miller effect-induced cross-conduction and further enhances robustness. It is available in a 7 mm x 7 mm 48-lead QFN package.

THE RISE OF WIRELESS ELECTRICITY

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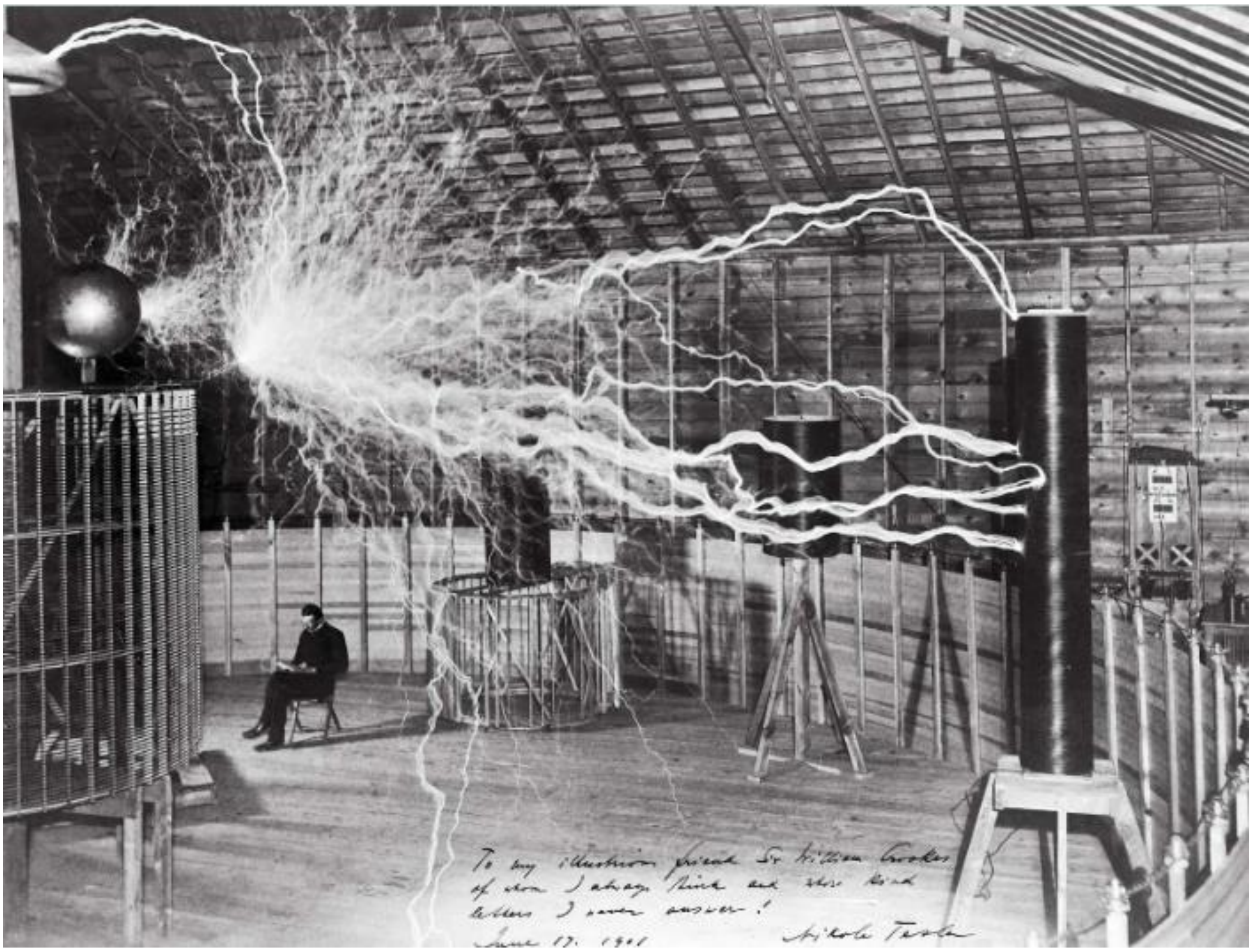


1. INTRODUCTION

In an increasingly connected world, the demand for efficient and convenient power transmission methods has never been higher. Wireless electricity, a concept once relegated to the realm of science fiction, is now becoming a reality, promising to revolutionize the way we access and use energy. This transformative technology holds the potential to change the way we live, work, and interact with our surroundings.

2. HISTORY OF WIRELESS ELECTRICITY

Wireless electricity, also known as wireless power transmission or WPT, is a cutting-edge technology that enables the transmission of electrical energy without the need for physical wires or direct electrical contact. Nikola Tesla, a visionary inventor, was one of the early pioneers of this concept in the late 19th and early 20th centuries. His work laid the foundation for the development of wireless

electricity as we know it today.The fundamental principle behind wireless electricity is electromagnetic induction, where an electric current is generated in one coil, and this current induces a voltage in a nearby coil without any direct connection. This process is governed by the laws of electromagnetism and has been refined and adapted to suit various applications over the years. One of the most well-known applications of wireless electricity is in the form of wireless charging for electronic devices, such as smartphones and electric vehicles.

3. WIRELESS CHARGING

Wireless charging technology has rapidly gained popularity in recent years, making it more convenient for users to recharge their devices without the hassle of plugging in cables. This technology is based on inductive charging, where a charging pad or base station sends an alternating current through a coil, which induces a current in a coil inside the device. This current is then converted into usable electricity to charge the device's battery. Companies like Apple and Samsung have integrated wireless charging into their products, and the technology is now widely adopted.

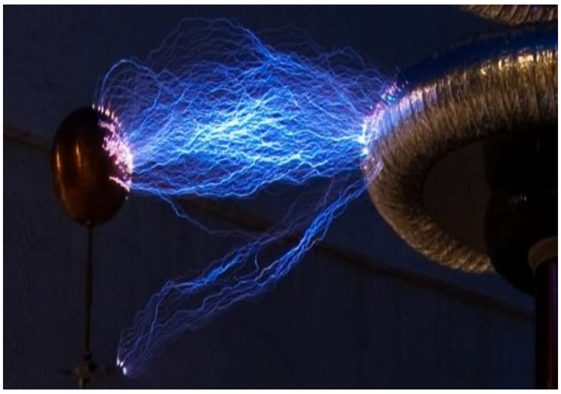
However, wireless electricity goes far beyond charging mobile devices. Researchers and innovators are exploring more ambitious applications. One of the most promising avenues is wireless power transmission over longer distances. This could have profound implications for industries ranging from healthcare to transportation.

4. APPLICATIONS

In the medical field, for instance, the ability to wirelessly power medical implants, such as pacemakers or cochlear implants, can eliminate the need for invasive surgeries to replace batteries. This not only reduces risks for patients but also extends the lifespan of these crucial devices.

4.1 Wider Range of Applications

In transportation, electric vehicles (EVs) stand to benefit significantly from wireless charging



infrastructure. While conventional EVs require physical connections to charging stations, wireless charging allows for automatic charging when the vehicle is parked over a charging pad embedded in the road. This promises to reduce charging times and make EVs more practical for daily use. Moreover, the adoption of wireless electricity could revolutionize public infrastructure. Imagine roads that charge electric vehicles as they drive or smart cities that power streetlights, traffic signals, and even buildings without unsightly overhead power lines. This technology has the potential to enhance urban aesthetics and reduce the risks associated with storms and natural disasters that can disrupt traditional power grids. However, wireless electricity is not without its challenges. One of the primary concerns is energy efficiency. The wireless transmission of electricity over long distances can result in energy losses due to electromagnetic radiation and other factors. Researchers are working to improve the efficiency of WPT systems to minimize these losses and make the technology more sustainable.

5. SAFETY IN WIRELESS ELECTRICITY

Safety is another critical aspect to consider. Ensuring that wireless electricity remains safe for both users and the environment is essential. Regulations and standards are being developed to address these concerns and create a framework for the widespread adoption of the technology. Privacy and security also come into play. As wireless electricity becomes more prevalent, there is a need to protect against unauthorized access and potential interference. Ensuring the secure transmission of power is crucial to maintaining the reliability and integrity of the electrical grid.

6. CONCLUSION

In conclusion, the development of wireless electricity is a remarkable advancement in the field of power transmission, with the potential to revolutionize various industries and our daily lives. While challenges remain, continued research and innovation promise to address these issues and bring us closer to a future where electricity flows through the air, making our world more connected, efficient, and sustainable. As we navigate this transformative journey, it is clear that wireless electricity is no longer science fiction but a reality with the power to shape the world of tomorrow.

WATER TURBINES

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1. INTRODUCTION

Water turbines are devices used to harness the kinetic energy of moving water and convert it into mechanical or electrical energy. They play a crucial role in hydropower generation, which is a renewable and environmentally friendly source of electricity. These turbines have evolved over time and come in various designs, each suited for different water conditions and power generation needs. Water turbines are vital components in hydroelectric power generation, harnessing the kinetic energy of flowing water to produce electricity. Positioned close to water bodies, these turbines serve as integral elements within hydroelectric power plants, converting the energy of moving water into electrical power.

2. DESIGNS

The design and placement of water turbines near water sources are crucial for maximizing efficiency and power output. Firstly, the selection of the turbine type depends on various factors like the flow rate, head (the vertical distance between the water source and the turbine), and the water body's size. One common type of water turbine is the Kaplan turbine, suitable for sites with low to medium head and high flow rates, often found in rivers or canals. Its adjustable blades allow for optimal performance across various water flow conditions. On the other hand, Francis turbines are used in medium head applications, like mountainous regions, converting water energy efficiently. Close proximity to the water body is necessary for these turbines to capture the energy effectively. Hydroelectric power plants are strategically located near rivers, dams, or reservoirs to ensure a constant and reliable water supply to turn the turbines. The water's gravitational force, often manipulated through the construction of dams or reservoirs, generates the necessary head or pressure to propel the turbines. In certain designs, the turbines are installed directly in the water body or within the dam structures themselves. Run-of-river hydroelectric plants, for example, divert a portion of the river's flow through the turbines without the need for extensive damming or reservoirs. These turbines are placed close to the river, allowing for efficient energy extraction without significantly altering the natural flow. The turbines themselves are positioned within housings called scroll cases or casings, designed to direct the water flow into the blades. The kinetic energy of the water causes the turbine blades to rotate, connected through a shaft to a generator, converting this mechanical energy into electrical power.

3. MAINTENANCE

Maintenance and environmental considerations are vital for the sustainable operation of water turbines located near water bodies. Regular maintenance, including cleaning debris from the intake screens and turbine surfaces, ensures efficient functioning and prolongs equipment lifespan. Additionally, environmental impact assessments are critical to minimize disruption to aquatic ecosystems and preserve the natural flow and habitats of rivers or water bodies. Furthermore, the design and installation of fish-friendly turbines aim to protect aquatic life. Modifications to turbine design, such as screens to prevent fish entry or slower rotational speeds, reduce the risk of harm to fish populations.

4. TYPES OF WATER TURBINES

4.1. IMPULSE TURBINES:

- **Pelton Wheel**
  Designed for high head (vertical drop) applications, the Pelton wheel uses jet-like streams of water to strike buckets mounted on the wheel's rim.
- **Crossflow (Banki-Michell) Turbine**
  Suitable for medium head applications, it employs a curved runner (blade) through which water flows both radially and axially.

4.2. REACTION TURBINES

- **Francis Turbine:** Ideal for medium to low head applications, the Francis turbine uses both pressure and kinetic energy as water passes through fixed and moving blades.
- **Kaplan Turbine:** Suited for low head applications, it has adjustable blades to optimize performance in varying flow conditions.
- **Propeller Turbine:** Commonly used in low head applications, similar to Kaplan turbines but with fixed blades.

5. WORKING PRINCIPLE

- **Impulse Turbines**

These use the force of the water's momentum to turn the turbine wheel.

- **Reaction Turbines**

Water pressure changes as it flows through the turbine, exerting force on the blades, which causes the turbine to rotate.

6. COMPONENTS OF A WATER TURBINE

6.1. Runner/Blades

The part that captures the energy from the flowing water.

6.2. Shaft

Transfers the rotational energy to the generator or other machinery.

6.3. Nozzles/Guide Vanes

Direct the flow of water onto the turbine blades.

6.4. Casing/Casing Liner

Encloses the turbine to control water flow and maintain efficiency.

7. EFFICIENCY AND APPLICATIONS

- Water turbines are highly efficient in converting water's kinetic energy into mechanical energy, often reaching efficiencies of 80-90%.
- They are used in various applications, including hydroelectric power plants, irrigation systems, water pumping stations, and industrial processes requiring mechanical power.

8. ENVIRONMENTAL IMPACT AND ADVANTAGES

- Water turbines are an environmentally friendly source of energy as they produce electricity without emitting greenhouse gases or other pollutants.
- They contribute to renewable energy production, reducing dependence on fossil fuels.

9. CHALLENGES AND FUTURE PROSPECTS

- The construction of large hydroelectric dams can impact local ecosystems and communities, leading to concerns about habitat disruption and displacement of people.
- Advancements in turbine design, materials, and efficiency continue to be explored to minimize environmental impact and improve overall performance.

10. CONCLUSION

Water turbines have been pivotal in harnessing the power of water for centuries. Their evolution and diverse applications in generating clean energy make them a crucial component of the renewable energy landscape. As technology progresses, optimizing their efficiency and minimizing environmental impact remain focal points for further advancements in this field. In conclusion, water turbines situated close to water bodies play a pivotal role in harnessing renewable energy from flowing water sources. Their placement and design are intricately linked to the characteristics of the water body, ensuring efficient energy extraction while minimizing environmental impact. These turbines contribute significantly to the global pursuit of sustainable energy generation and the reduction of reliance on non-renewable resources.

HYDROGEN FUEL CELL CAR

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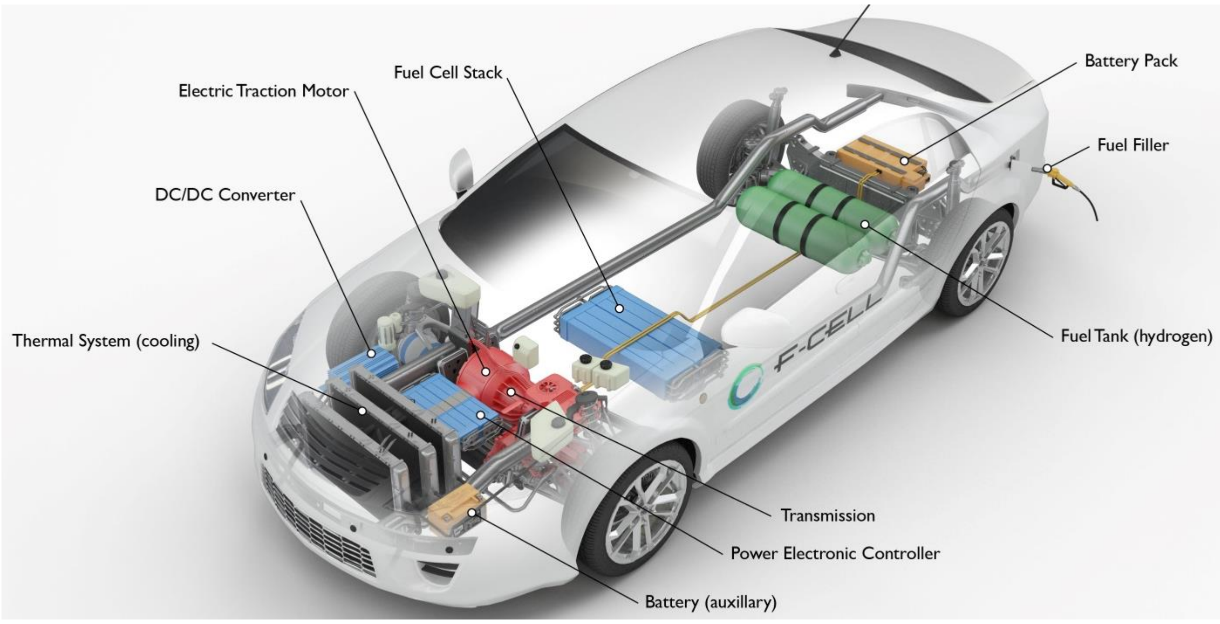


1. INTRODUCTION

India is making progress in the field of hydrogen fuel cell electric cars (FCEVs), which have the ability to power vehicles without emitting any pollution. FCEVs use hydrogen gas to power an electric motor, producing only water as a byproduct. These cars offer numerous benefits, including high efficiency, long range, quick refueling, and minimal noise. India, as a developing nation with significant air pollution and energy consumption concerns, has been exploring renewable and alternative energy sources like hydrogen. The country has been promoting the use of electric cars (EVs) through initiatives like FAME and NEMMP, but FCEVs can complement EVs and provide a viable solution for clean and environmentally friendly mobility. FCEVs can also utilize existing infrastructure for compressed natural gas (CNG) to distribute hydrogen.

2. DEVELOPMENT

India has achieved significant milestones in the development of hydrogen fuel cell technology. In 2020, the Council for Scientific and Industrial Research (CSIR) and KPIT successfully tested India's first hydrogen fuel cell vehicle. The vehicle utilized a locally produced low-temperature PEM fuel cell and achieved a range of 250 km per kilogram of hydrogen. Furthermore, the Union Ministry for Road Transport and Highways, in collaboration with Toyota Kirloskar Motor and the ICAT, initiated India's first hydrogen-powered FCEV project. The project involves testing the Toyota Mirai, a cutting-edge FCEV, on Indian roads and in Indian weather conditions. The Toyota Mirai offers a five-minute refueling time and a range of up to 650 kilometers on a single charge. The project aims to increase awareness and understanding of FCEV and hydrogen technology in India.

3. GOVERNMENT INITIATIVES

Nitin Gadkari, the Union Transport Minister, drove India's first hydrogen-powered car to Parliament in 2023 to emphasize the importance of transitioning to green and renewable energy sources. The government plans to produce green hydrogen using biomass and renewable energy to reduce India's dependence on imports and fossil fuels. Additionally, the government intends to launch hydrogen-powered buses from Delhi to Jaipur. The development and adoption of hydrogen cars in India face challenges such as cost, safety, standards, laws, policies, incentives, awareness, and collaboration. However, with coordinated efforts from the government, businesses, universities, and civil society, India has the potential to lead the world in hydrogen car technology and pave the way for a hydrogen-based society.

4. FCEV IN INDIA

India is exploring hydrogen fuel cell electric cars (FCEVs) as a clean and efficient alternative to conventional vehicles. FCEVs use hydrogen gas to power an electric motor and produce only water as a by-product. India has successfully tested its first hydrogen fuel cell vehicle, achieving a range of 250 km per kilogram of hydrogen. The government, in collaboration with Toyota Kirloskar Motor and the ICAT, has initiated India's first hydrogen-powered FCEV project, testing the Toyota Mirai. Nitin Gadkari, the Union Transport Minister, highlighted the importance of transitioning to green energy sources and plans to produce green hydrogen using biomass and renewable energy.

5. DEVELOPMENT AND KEY COMPONENTS

The development and adoption of hydrogen cars in India face challenges such as cost, safety, standards, laws, policies, incentives, awareness, and collaboration. Key Components of a Hydrogen Fuel Cell Electric Car are following.

5.1 Battery (Auxiliary)

In an electric drive vehicle, the low-voltage auxiliary battery provides electricity to start the car before the traction battery is engaged; it also powers vehicle accessories.

5.2 Battery Pack

This high-voltage battery stores energy generated from regenerative braking and provides supplemental power to the electric traction motor.

5.3 DC/DC Converter

This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

5.4 Electric Traction Motor (FCEV)

Using power from the fuel cell and the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.

5.5 Fuel Cell Stack

An assembly of individual membrane electrodes that use hydrogen and oxygen to produce electricity.

5.6 Fuel Filler

A nozzle from a fuel dispenser attaches to the receptacle on the vehicle to fill the tank.

5.7 Fuel Tank (Hydrogen)

Stores hydrogen gas on-board the vehicle until it's needed by the fuel cell.

5.8 Power Electronics Controller (FCEV)

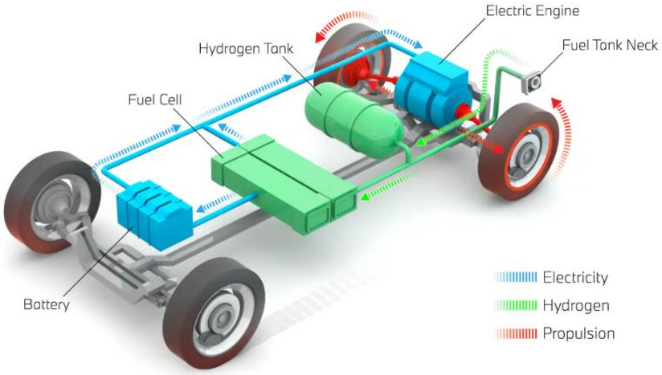
This unit manages the flow of electrical energy delivered by the fuel cell and the traction battery, controlling the speed of the electric traction motor and the torque it produces.

5.9 Thermal System (Cooling) for (FCEV)

This system maintains a proper operating temperature range of the fuel cell, electric motor, power electronics, and other components.

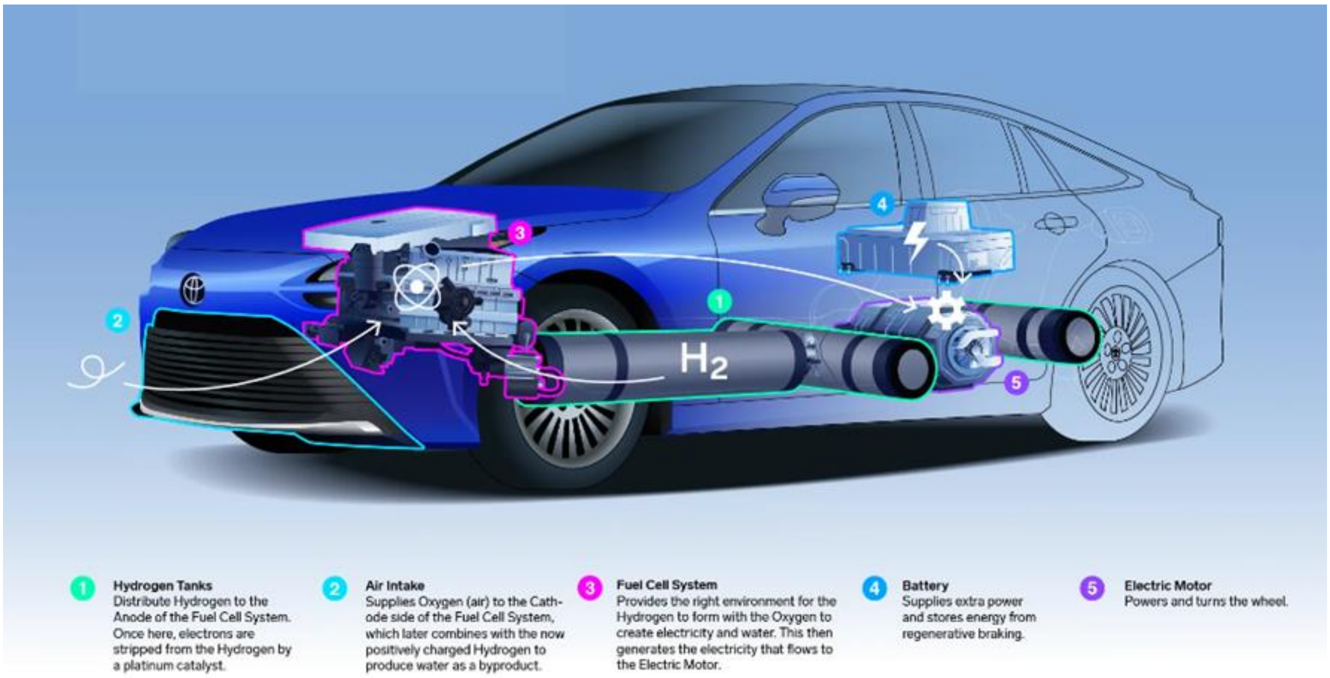
5.10 Transmission (Electric)

The transmission transfers mechanical power from the electric traction motor to drive the wheels.



6. CONCLUSION

Hydrogen fuel cell cars are quiet, very energy efficient, produce no emissions and have equivalent range and performance to gasoline counterparts. Drivers identify range, refueling time, emissions, power and performance as valuable vehicle characteristics. While a fuel cell car acquisition can cost more than comparable sized conventional cars, current leasing packages usually include fuel, service and maintenance to compensate. With these incentives included, total cost of ownership for a fuel cell car can be comparable to conventional cars. Fuel cell cars can carry enough hydrogen fuel for 300-400 miles of range and their tanks can be refilled as quickly as that of a standard car’s gas tank. Current lease deals often include up to three years of complimentary fuel. At the pump, hydrogen sells for considerably more than gasoline, however, a fuel cell car travels about twice as far as a conventional car on an equivalent amount of fuel.



TRANSPARENT SOLAR PANELS: REFORMING FUTURE ENERGY SUPPLY

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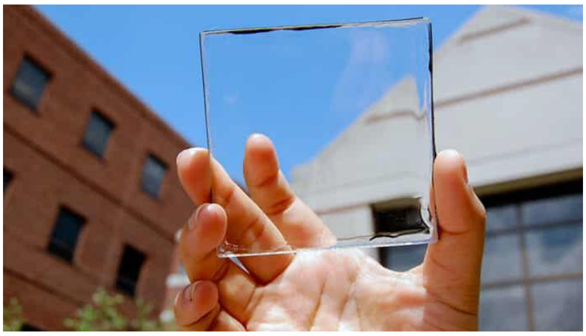
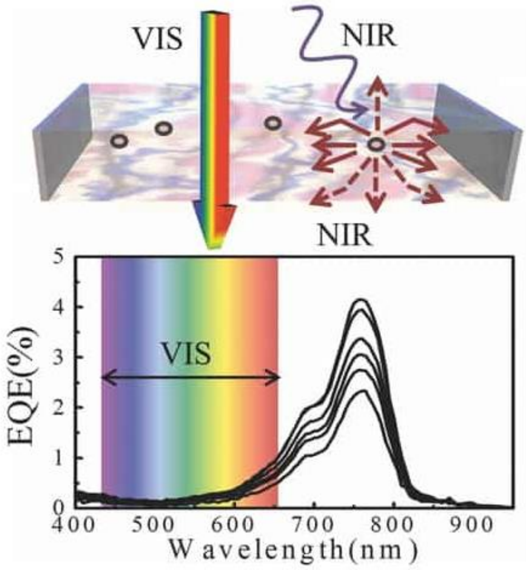
1. INTRODUCTION

New solar panel technologies are set to transform the global solar energy landscape. Some of these promising technologies are already in the advanced stages of development, and could hit the market fairly soon. With these innovations, solar is no longer going to require extensive land parcels or unsightly roof spaces. (Aesthetically appealing and highly efficient solar shingles, for example, are already creating attractive solar roofs.)



2. WHAT ARE TRANSPARENT SOLAR PANELS?

Photovoltaic glass is probably the most cutting-edge new solar panel technology that promises to be a game-changer in expanding the scope of solar. These are transparent solar panels that can literally generate electricity from windows—in offices, homes, car's sunroof, or even smartphones. Blinds are another part of a building's window that can generate electricity (we will discuss it in a later section). Researchers at Michigan State University (MSU) originally created the first fully transparent solar concentrator in 2014. This clear solar panel could turn virtually any glass sheet or window into a PV cell. By 2020, the researchers in the U.S. and Europe have already achieved full transparency for the solar glass. These transparent solar panels can be easily deployed in a variety of settings, ranging from skyscrapers with large windows to a mobile device such as a phone, a laptop, or an e-reader. As these solar power windows can simply replace the traditional glass windows in offices and homes, the technology holds the potential to virtually turn every building in the United States and the world into a solar producer.



3. HOW DO SOLAR PANEL WINDOWS WORK?

A transparent solar panel is essentially a counterintuitive idea because solar cells must absorb sunlight (photons) and convert them into power (electrons). When a solar glass is transparent, the sunlight will pass through the medium and defeat the purpose of utilizing sunlight. However, this new solar panel technology is changing the way solar cells absorb light. The cell selectively harnesses a portion of the solar spectrum that is invisible to the naked eye, while allowing the normal visible light to pass through. To achieve this technological wonder, the researchers have developed the transparent luminescent solar concentrator (TLSC) rather than trying to do the impossible by creating a transparent photovoltaic glass cell. The TLSC is composed of organic salts that are designed to absorb specific invisible UV and infrared light wavelengths, which then glow (luminesce) as another invisible wavelength. This new wavelength is then guided to the edge of the window plastic, which thin PV solar cell strips convert it into electricity. Once the mass production begins for transparent solar panels, researchers estimate that the TLSC should be able to deliver an efficiency of about 10%. This may not appear to be an earth-shattering number, but on a national or global scale, when almost every window in a home or office building consists of clear solar panels, the results can be transformative. As the transparent solar panels cost comes down with their mass production and deployment, this non-intrusive technology can be scaled right from commercial and industrial applications to handheld consumer devices, while remaining very affordable.

4. TYPES OF TRANSPARENT SOLAR PANELS

Just the way solar roof panels are currently produced using different technologies (Tesla's solar shingles and other technologies), solar windows are also being developed using different techniques. The two major types of transparent solar panels include partial and full transparent panels.

4.1 Partially Transparent Solar Panels

A German manufacturer, Heliatek Gmb, has developed this partially clear solar panel, which can absorb about 60 percent of the sunlight it receives. Compared to the conventional solar PV cells, the partially transparent solar panels have a lower efficiency at 7.2%. However, solar power generation can be increased by adjusting the balance between the sunlight that is transmitted and absorbed. For instance, in south-facing glass buildings, it is often important to reduce the transmitted light (many such office buildings already use tinted glass). In these locations, the partially transparent solar panel can work very well.

4.2 Fully transparent solar panels

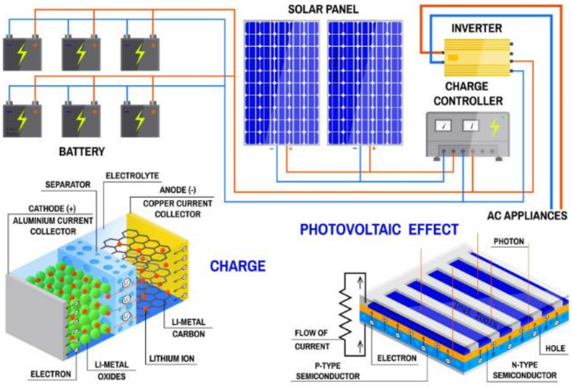
As described in the beginning of this report, researchers at MSU have already achieved a breakthrough to produce fully transparent photovoltaic glass panels that resemble regular glass. Researchers estimate the efficiency of these fully transparent solar panels to be as high as 10% once their commercial production commences. It's vital to understand here that when it comes to solar panel windows, efficiency of the panel is not the be all and end all. In practical terms, a less efficient solar window only means that the window has to be larger in size compared to the more efficient panel in order to generate the same amount of electricity. Once fully transparent solar panels get integrated into large windows in buildings, their lower efficiency is bound to be overcompensated by their potential scale of deployment.

5. SOLAR PANEL BLINDS AN EASY-TO-IMPLEMENT SOLAR WINDOW TECHNOLOGY

Solar panel blinds are a supplement to transparent solar glass/panels when using the window to generate electricity. Solar power panels are designed to harvest sunlight to produce energy, while the essential function of window blinds is to block direct sun's rays from entering inside. Solar panel blinds are cleverly combining these two divergent functions. An innovative startup called SolarGaps has introduced solar panel blinds, which it claims can cut down energy costs by up to 70 percent. For every 10 sq. ft. of window space, these solar window blinds can generate 100 watts of power (you could roughly power three laptops with this much electricity). These solar blinds can be installed either inside or outside, and you can control their angle and positioning using an app that will also inform you of the energy generation figures. It includes a setting to automatically optimize the angle of the blinds according to the position of the sun.

6. PIONEERS IN TRANSPARENT SOLAR PANEL RESEARCH AND MANUFACTURING

Researchers at Michigan State University and MIT as well as manufacturers such as Ubiquitous Energy, Physee, and Brite Solar are pioneers in promoting this new solar panel technology.



6.1 Ubiquitous Energy

Ubiquitous Energy, in partnership with a leading glass manufacturer NSG Group, is developing Ubiquitous's unique ClearView Power technology to integrate transparent solar panels into architectural glass windows. ClearView Power's transparent solar coating can be directly applied to building windows at the time of the normal glass making process. The technology also enhances energy efficiency of the buildings through blocking of infrared solar heat. When combined with solar energy generation through clear solar panels, it can lead to net-zero energy buildings. The company has already announced that ClearView Power's transparent solar cells have reached an electricity conversion efficiency of 9.8%.

6.2 Physee

Physee is a European manufacturer that has introduced an advanced product called Power Window. In fact, it is the only currently installed transparent solar panel in the world right now (covering 300 sq. ft. in a Dutch bank building). Physee's Power Window makes use of small solar panels that are installed along the window pane edges to generate power. While these solar windows are unable to be a standalone power source for buildings yet, the company is confident of rapid improvements in the scale and efficiency of its transparent panels. PowerWindows serve as the building blocks for "SmartSkin," the clear photovoltaic glass that the company is promoting as the "future-proof glass façade for next-generation sustainable buildings." SmartSkin can work autonomously to sense, power, and regulate the climate inside the building using intelligent systems.

7. THE FUTURE OF TRANSPARENT SOLAR TECHNOLOGY

The potential to generate renewable, clean energy from the sun is enormous with transparent solar panels, considering the number of skyscrapers and buildings already in existence or under construction with a massive amount of glass surface. According to Richard Lunt, the Johansen Crosby Endowed Associate Professor of Chemical Engineering and Materials Science at MSU, highly transparent solar cells represent the "wave of the future" for new solar panel technologies. Lunt says that these clear solar panels have a similar power-generation potential as rooftop solar, along with additional applications to improve the efficiency of buildings, cars and mobile devices. Lunt and his team estimate that the U.S. alone has about 5 to 7 billion square meters of glass surface at present. (Just in the last 10 years, as much as 682 million sq. ft. of office space has been added in the U.S.).

8. CONCLUSION

With this much of glass surface to cover, transparent solar panel technology has the potential to meet about 40 percent of the country's annual energy demand. This potential is nearly the same as that of rooftop solar. When both these technologies are deployed complimentarily, it could help meet nearly 100 percent of the U.S. electricity needs if we also improve energy storage.

CHARGING INFRASTRUCTURE AND ENERGY MANAGEMENT

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1. INTRODUCTION

Welcome to the future of electric vehicle charging – Battery Swapping. So, what is it exactly? Imagine driving your EV and instead of waiting hours to charge, you simply swap out the depleted battery for a fully charged one, all in a matter of minutes. Just like the image shows, stations like these from 'Gogoro Network' provide a bank of charged batteries. When your battery runs low, pull up, take out your old one, and slot in a new one. The benefits? Reduced waiting times, extended vehicle range, and it's especially great for urban areas with limited charging infrastructure. Think of it as a refuel for EVs but faster and more efficient. This, indeed, is a game-changing technology for electric vehicles

2. BENEFITS OF ENERGY MANAGEMENT

2.1 Convenience

Battery swapping offers a quick solution for EV drivers. Instead of waiting for hours, you can get a fully charged battery in minutes.

2.2 No Charge Anxiety

With swapping stations around, drivers don’t need to worry about their battery running out.

2.3 Efficient Resource Use

It promotes the reuse of batteries, making the most out of each one.

2.4 Potential for Lower Costs

As the technology matures, it’s possible to have cost-effective stations that can be easily replicated.

3. CHALLENGES OF ENERGY MANAGEMENT

3.1 Initial Setup Cost

Establishing a battery-swapping station requires significant investment.

3.2 Limited Availability

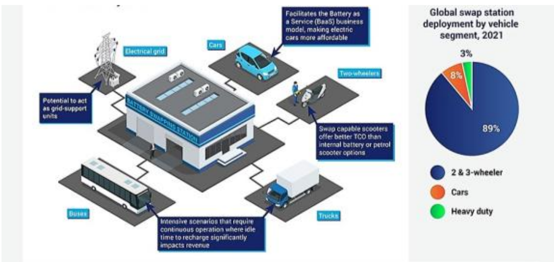
There are still only a handful of these stations worldwide, limiting its current feasibility.

3.3 Swapping Speed

While faster than charging, swapping isn't instant. It's still slower compared to filling up a gas tank.

3.4 Concerns from Manufacturers

Some EV makers are hesitant about battery swapping due to worries about potential harm to the batteries.



4. AN INDUSTRY OFFERED BATTERY SWAPPING STATION DESIGN

4.1 Central Structure

At the heart is the 'Battery Swapping Station', a facility equipped to swiftly change out depleted batteries for fully charged ones, ensuring minimal wait time.

4.2 Integration with Grid

These stations have the potential to double up as grid-support units, showcasing a seamless integration with our existing electrical grid.

4.3 Diverse Vehicle Support

From cars to two-wheelers, buses, and heavy-duty trucks, these stations are designed to cater to a range of vehicles. Notably, swap-capable scooters present a better Total Cost of Ownership (TCO) than their internal battery or petrol counterparts.

4.4 Business Model
Adopting a 'Battery as a Service' model, these stations can make electric vehicle ownership more affordable, by eliminating the upfront cost of batteries for consumers.

4.5 Operational Efficiency
For scenarios demanding continuous operation, like buses and trucks, idle time for recharging can dent revenues. Swapping stations mitigate this by slashing downtime.

4.6 Global Perspective
A pie chart depicts the global deployment of these stations in 2021. A whopping 89% cater to 2 & 3-wheelers, followed by cars and heavy-duty vehicles.

In essence, battery swapping stations are more than just charging alternatives; they are transformative solutions for sustainable mobility.

5. WORKING OF BIDIRECTIONAL EV CHARGING

The Bidirectional charging is not just about taking energy from the grid to power your EV. It's a two-way street. This means while your vehicle can draw power from the grid, it can also send energy back. This dual functionality offers a host of benefits not only for the EV owner but also for the larger electrical grid. Charging the Vehicle: When you plug in your EV to a charging station, it draws electricity from the grid. This process is tailored to the needs of the vehicle and the capabilities of the charging station, ensuring efficient and safe charging. Vehicle-to-Grid (V2G) Charging: This is where the magic happens! V2G charging uses a special two-way converter, allowing your EV to discharge some of its stored energy back into the grid. Why is this important? Imagine peak times when everyone is using electricity. Instead of overloading the grid, EVs can contribute and balance out the demand. The EV battery acts as a temporary energy source, helping to stabilize the grid and reduce peak loads. In essence, bidirectional EV charging is a game-changer. It is about smarter energy use, benefiting both individual EV owners and our broader communities.

6. THE CONCEPT

Unlike traditional EV charging, smart roads enable vehicles to charge on-the-go. This is achieved through copper coils embedded beneath the road surface, which transfer power magnetically to a receiver pad on the bottom of your EV. As you drive or even when you are parked, energy travels from these underground copper coils directly to your vehicle. This is done magnetically, meaning no wires, no plugs, and no waiting. It's continuous and seamless. In summary, smart roads represent a leap forward in EV infrastructure, offering convenience and efficiency. As we transition to a more sustainable future, technologies like these pave the way for a more interconnected, energy-smart world. Imagine arriving at a parking lot and being greeted not just by a regular charging station, but one enhanced with artificial intelligence (AI).

7. USER EXPERIENCE

As evident from the image, this isn't your ordinary charging station. It's equipped with a digital screen displaying advertisements. The charging station can curate ads or messages based on the data it collects, enhancing the user experience.

7.1 Connectivity
Through AI and Internet of Things (IoT) integration, these stations can communicate with each other, relaying information about availability or potential maintenance needs. Additionally, they can provide drivers with information about nearby amenities, like the nearest elevator in the parking lot.

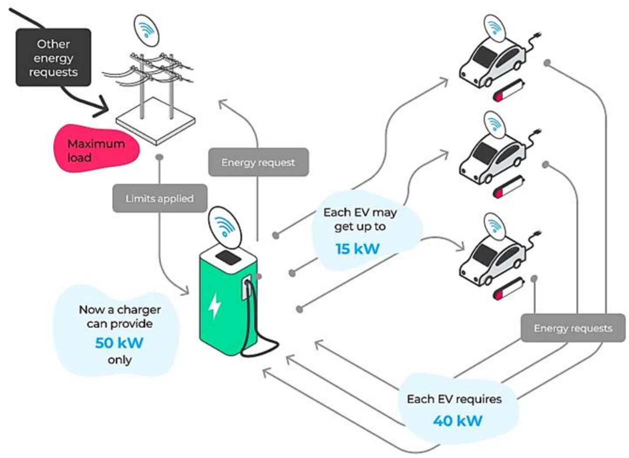
7.2 Green Energy
Now it’s time to go greener. The solar based charging. Solar Energy Source: The system begins with our primary energy source: the Sun. As sunlight strikes the solar panels - whether they're on rooftops or specially designed carports - it's converted into electrical energy.

7.3 Conversion & Storage

Once generated, this direct current (DC) electricity flows into the solar inverter. Think of this device as a translator, converting the DC into alternating current (AC) that our appliances and systems use. From there, the AC combiner effectively combines the energy produced from various panels. Smart Metering: Before this energy can power our cars, it's routed through a smart meter. This device provides real-time data on energy consumption, ensuring the system runs efficiently and economically. Energy Storage: Not all generated energy is used immediately. Excess energy charges batteries in the energy storage system, ensuring that even during periods without sunlight, vehicles can still be charged. Imagine a bustling city with numerous electric vehicles (EVs) needing a charge. Every time an EV is plugged into a charger, it sends an 'Energy request' to the local energy grid. Now, if each of these vehicles demands 40 kW of power, and there are multiple vehicles charging simultaneously, the load on the energy grid can be immense. However, the local grid has its constraints. It needs to cater to 'Other energy requests' from homes, businesses, and other services. This grid has a 'Maximum load' it can handle. To avoid overloading, the system applies 'Limits'.

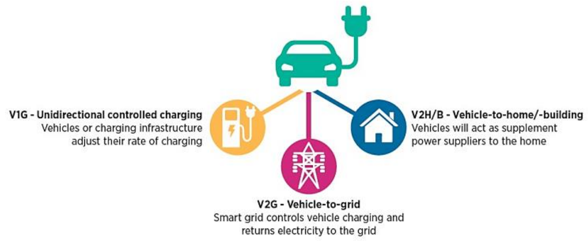
7.4 Communication

The magic here lies in the communication. With smart charging, the grid communicates back to the EV chargers, telling them the maximum power they can draw. In this scenario, even if each EV desires 40 kW, the charger might only be allowed to provide up to 15 kW based on the current grid capacity, which is adjusted in real-time. Here, our charger can provide a maximum of 50 kW at this time, divided among the EVs. What we see is a harmonious dance, a 'Single ecosystem', where EVs, their chargers, and the local energy grid are in constant communication, ensuring power is distributed efficiently without overburdening the grid.



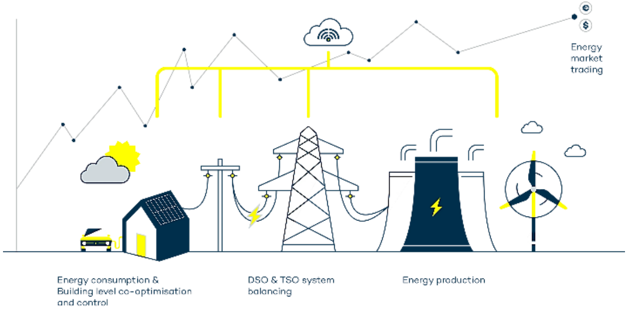
7.5 Economical

At the top, we see the principle of smart charging. It's the automatic scheduling of electric vehicle charging during hours when electricity demand is low, maximizing efficiency and savings. Looking at the graph, we notice the electricity pricing varies throughout the day. Peak times, like late afternoons and early evenings, have the highest rates at $0.34/kWh. Then we transition to off-peak times at $0.14/kWh. Finally, during the early hours, we hit the super off-peak at a mere $0.11/kWh. Now, imagine you come home from work around 6 pm and plug in your EV. If you were to charge immediately, you'd be paying peak rates. However, with smart charging, your car begins charging around midnight, utilizing the cheaper rates, and completes by early morning. Your cost to charge is only $7.14, leading to substantial savings. In fact, an average user can save up to $388 per year!

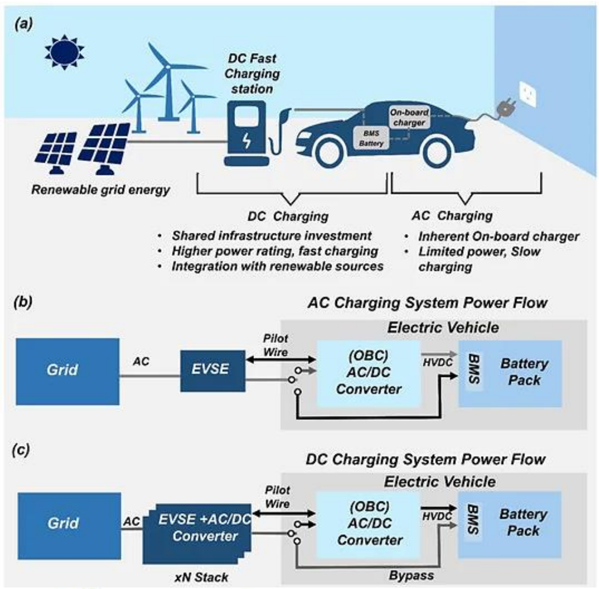


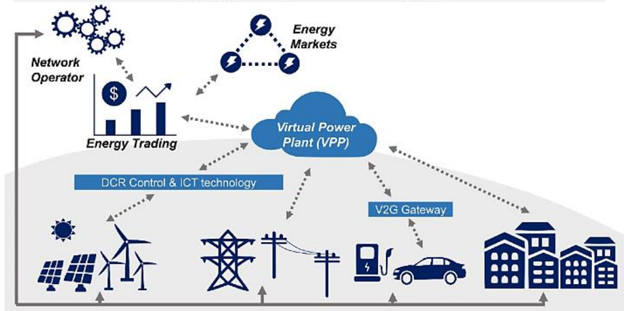
8. V2G TECHNOLOGY

We dive into the world of V2G Technology, which stands for Vehicle-to-Grid. What does it mean? Well, imagine your electric vehicle not just consuming energy, but also providing it back to the power grid! Yes, that's what V2G does. First, there's V1G, or Unidirectional controlled charging. This is where your car, or the charging infrastructure, can adjust how fast it's charging. So, instead of always charging at maximum speed, we can vary it, which is kinder to the grid. Moving on to the main feature: V2G. This is bidirectional. It means the smart grid doesn't just control how the vehicle charges, but the vehicle can also return electricity to the grid when it's not in use. It's like your car becoming a mini power plant when it's parked! Lastly, see the house symbol? That's V2H/B, meaning Vehicle-to-



Home/Building. Your car's battery can act as a backup power source for your home or even a building. Imagine, during a blackout, your car powers your house! We're now moving beyond just Vehicle-to-Grid (V2G). We're venturing into the realm of 'Vehicle-to-Everything' or V2X. You'll see various elements on this slide, each symbolizing a unique aspect of energy interaction. Starting from the left, we see energy consumption and building-level co-optimization. Simply put, it's about efficiently using and distributing energy in buildings, leveraging car batteries when needed.Next, there's the DSO & TSO system balancing, which represents the balance between energy supply and demand. It ensures that the energy grid remains stable by managing fluctuations. On the right, we have the concept of energy market trading. This hints at the possibility of vehicles not just being consumers, but also playing a role in the broader energy market, potentially even profiting from it! Now, the text on the slide emphasizes the diverse use cases of V2X. It's not just about sending energy back to the grid or our homes. It's about a holistic





approach where vehicles can provide power to homes (V2H), buildings (V2B), and even directly to other loads or devices (V2L).

9. SOLUTIONS IN EV CHARGING

We look at industries. When we talk about leaders in the EV charging domain, several prominent companies come to the fore. Let's quickly dive into the main players in this sector.

Tesla: Not just a car manufacturer, they've made a significant mark with their Supercharger network.
Blink: Renowned for their accessible charging solutions spread across various locations.

ChargePoint: One of the largest EV charging networks, they provide a vast range of charging solutions.

ABB: Globally recognized for their fast-charging stations, they're making rapid strides in electrifying transport.

Siemens: Their versatile charging technologies cater to both public and private spaces.

Schneider Electric: Known for energy management, they've carved a niche in EV charging infrastructure.

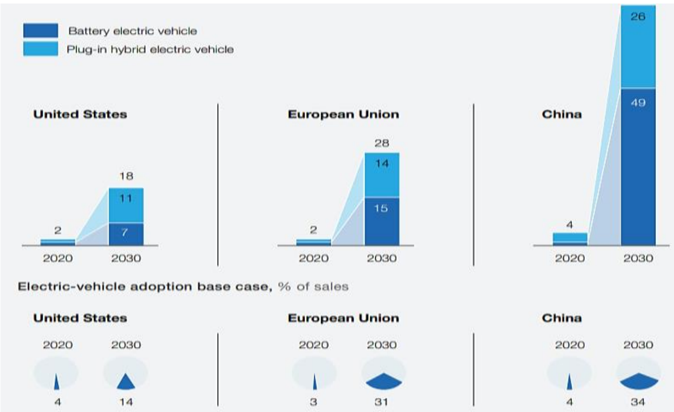
Efacec: With a rich heritage in electric mobility, they offer a comprehensive range of chargers.

Star Charge: Emerging as a reliable name, their solutions are designed for user convenience.

These companies are at the forefront of addressing EV charging challenges, ensuring a sustainable and efficient future for electric mobility both in India and globally.

10. GLOBAL PERSPECTIVE

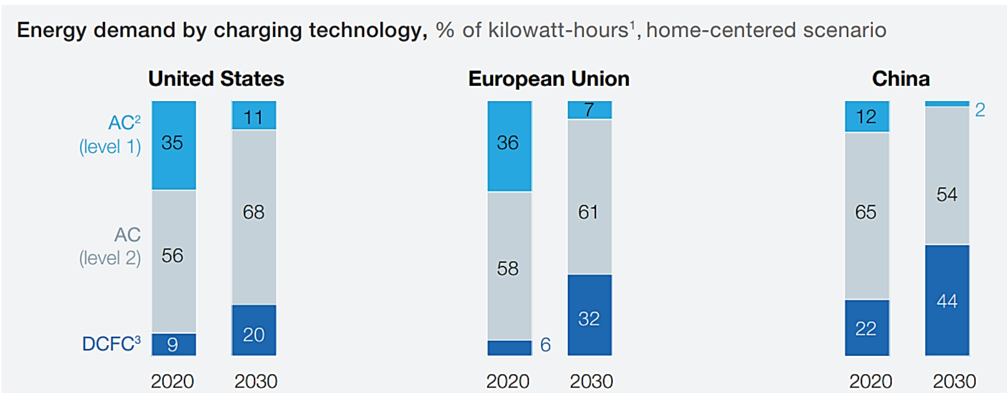
Let's zoom out and take a global perspective on the surging demand for electric vehicles. By



2030, anticipate a staggering 120 million electric vehicles plying the roads worldwide. That's a monumental shift from traditional combustion engines! Delving into the specifics of charging – Level 1 and Level 2 charging methods are projected to remain at the forefront of energy demand for EVs. A glimpse into energy demand by charging technology reveals that the United States, for example, will see a substantial increase in both AC Level 1 and Level 2 charging, with DCFC3 also gaining traction by 2030. Similarly, the European Union and China are expected to follow this trend, though with their unique patterns. Now, looking at the electric vehicle adoption rates, the U.S., European Union, and China are gearing up for rapid acceleration. China, in particular, is racing ahead with a prediction of 74 million electric vehicles by 2030, while the European Union and the U.S. are also on an upward trajectory.

10. CONCLUSION

The data underscores a clear message: the future is electric, and the need for robust charging infrastructure is imperative. As educators and future innovators, recognizing these trends now positions us to lead the charge in sustainable transportation solutions.



ANALYSIS OF HARMONICS IN DIMMABLE LED DRIVER

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1. INTRODUCTION

Now a days compact fluorescent lamp (CFL) and light emitting diode (LED) are becoming more popular when in early days incandescent lamp are used. CFL and LED are more efficient than incandescent lamp. In 2022 CFL and LED especially LED'S have spread everywhere.in very few places incandescent lamps are used. But in case of load analysis, two types of loads, those are linear and non-linear. As CFL and LED'S are highly non-linear load, it produced highly distorted current and it will generate harmonics in the system also poor power quality. By running the LED and CFL lamp load it is necessary to improve the harmonics by design a filter. (Single tuned passive filter) That is also known as notch filter. That filter will reduce the harmonics as standard (IEEE 519 – 2014) that is constant voltage harmonics range 2.2% - 5%. And current harmonic range is 30%. This single tune filter can reduce 3rd, 5th & 7th harmonics and also decrease THDi. A large number of LED are using domestic, industrial lighting could causes power quality problem. When we are talking abought energy savings, dimming is one of key process. When dimming is done in a particular LED driver, that harmonics filter is no longer kept the THD level as standard.

2. HISTORY OF HARMONICS

LED are so popular now a days because of its reliability, low power consumption, environment friendly, operate in cold condition, higher efficiency and longer life. But to design a LED driver circuit many non-linier components are used. Though LED drives in DC Voltage and our domestics supply is in AC, so 1st we have to rectify the AC in to DC. After that for constant current or constant Voltage drive, we have to filter the pulsating DC into smooth DC, then reduced the DC voltage using DC-DC converter. But the problem is by using those components our input source current and voltage is no longer sinusoidal. (Non-sinusoidal but periodic) So Harmonics is present the system. To solve this issue just place a harmonics filter which is also known as Knoch filter, (Series inductor with supply & parallel Capacitor across supply) by calculating the value at a particular power we can easily design the input inductor, Resistance and capacitor. But now a days energy savings is one of the keys concerned in the planet. In case of lighting load, the energy savings means dimming. But whenever we are trying to dim our LEDs the power is change, due to the change in the power, input filter is no longer works properly to maintain the Current harmonics. Electrical loads which draw sinusoidal current from sinusoidal voltage are called linear load. Those are consisting of passive element such as resistance, inductance & capacitance. Where non-sinusoidal load draws non-sinusoidal waveform from an input sinusoidal voltage source. In order to show the non-sinusoidal effect. Harmonics definition was introduced by IEEE (Institute of Electrical & Electronics Engineers) in the year of 1981. Acceding to IEEE harmonics is known as "A sinusoidal component of a periodic signal which consist of a frequency that is an integer multiple of the fundamental frequency. In other words, we can also say that the harmonics is the sum of the sinusoidal waveform in different frequency by Fourier series. The non-linier loads will cause distorted voltage and current waveform. Total harmonic distortion (THD) is the addition of individual harmonics components of the voltage & current with the Respect to the fundamental voltage & current.

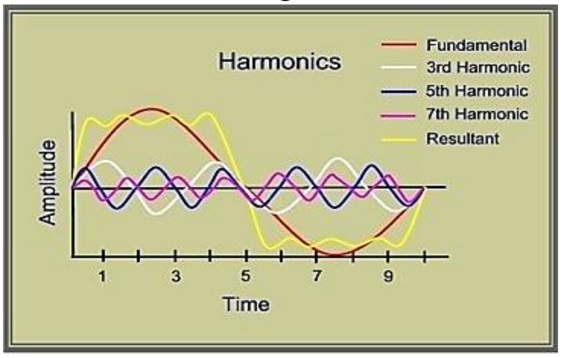


Figure 1 Block diagram of a typical Harmonic Signal

Electrical loads which draw sinusoidal current from sinusoidal voltage are called linear load. Those are consisting of passive element such as resistance, inductance & capacitance. Where non-sinusoidal load draws non-sinusoidal waveform from an input sinusoidal voltage source. In order to show the non-sinusoidal effect. Harmonics definition was introduced by IEEE (Institute of Electrical & Electronics Engineers) in the year of 1981. Acceding to IEEE harmonics is known as "A sinusoidal component of a periodic signal which consist of a frequency that is an integer multiple of the fundamental frequency. In other words, we can also say that the harmonics is the sum of the sinusoidal waveform in different frequency by Fourier series. The non-linier loads will cause distorted voltage and current waveform. Total harmonic distortion (THD) is the addition of individual harmonics components of the voltage & current with the Respect to the fundamental voltage & current.

3. POWER CONVERSION IN LED DRIVER

In my tropology I am using various power conversion process such as, AC to DC, DC to DC. In Dc-to-DC conversion buck converter, flyback converter etc.so I am trying to gone through all the basic things to understand very easily. We have studied the operation and V/I characteristics of a PN junction diode in the previous chapter. We have also seen that the diode can conduct only when it is forward biased, blocks when it is reversed biased. This property of diode makes it an important component of DC power supplies which are used to power electronic system. The block diagram of a typical DC power supply is shown in Fig 2

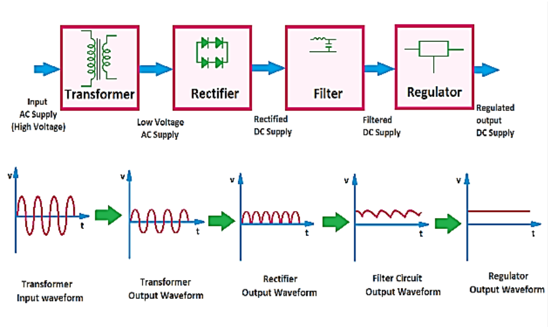


Figure 2 Block Diagram of a Typical DC Power Supply

The transformer is used to step down the AC voltage to desired voltage level by depending upon the turn's ratio N2:N1. The transformer also provides electrical isolation to the power electronics circuit. Fast the rectifier converts AC voltage to pulsating DC, then the pulsating dc is smoothened by filter circuit. Finally, we get the almost constant waveform.

4. POWER CONVERTER TROPOLOGY TO REDUCED THD

Now it is time to implement few tropology and trying to reach our objective that is control the input current harmonics (THD). Firstly, we have to quickly compare our tropology with some other basic tropology. As we already know that for LEDs, we need DC supply. There are plenty of options to make DC power supply. Just using a step-down transformer with a rectifier in figure 3.

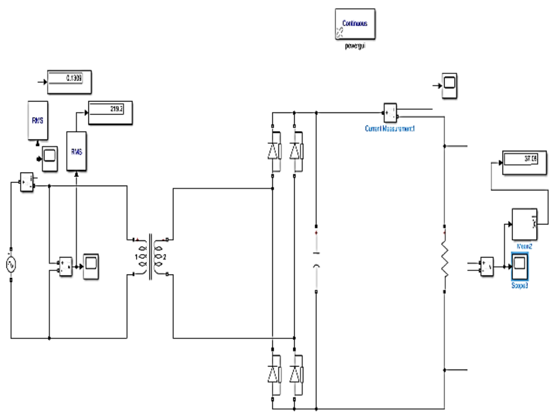


Figure 3 Basic Rectifier with a Step-Down Transformer

This is very old and basic DC power supply. But the main problem is the losses, and the supply current is no longer sinusoidal.it will contain 25.69% of THD. Figure 4

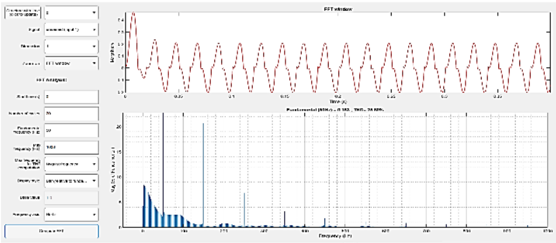


Figure 4 Basic Rectifier with a step-down transformer THD analysis

Then we can omit the step-down transformer and use a buck converter for DC supply figure 5. Hare the THD level is improved 19.08% but it’s doesn’t match our objective in figure 6.

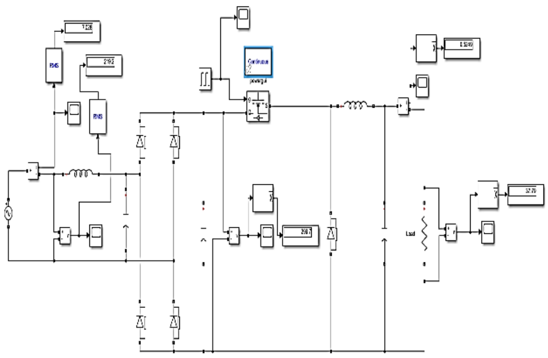


Figure 5. Buck Converter

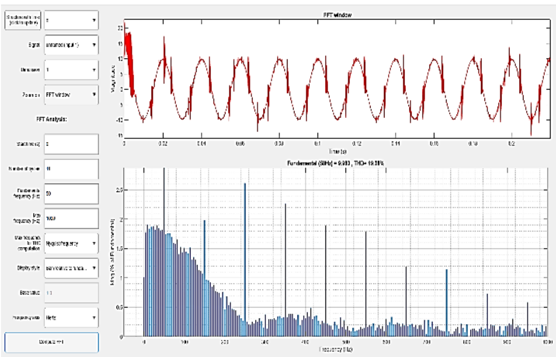


Figure 6 Buck Converter THD Analysis

In figure 5 it lags the isolation between input and output so next we use transformer with DC-DC buck converter in figure 7.

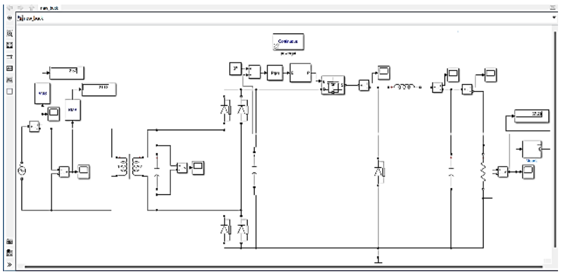


Figure 7 Isolated Buck converter

In this configuration THD level is 7.66% in figure 8. But it is still not up to the mark.

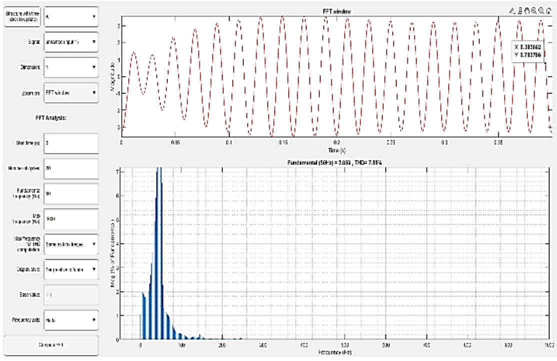


Figure 8. Isolated Buck Converter THD Analysis

For this we can use Integrated Buck Flyback Converter (IBFC). This is very similar to figure 7 with interchanging some component and add a polarised transformer. In IBFC the buck converter and the Flyback converter works in a cascade mode figure 9. This IBFC presents several good features like fast output regulation, low current through the main switch and low voltage at buck output. But it’s showing a limitation in THD and PF. When dimming is applied it became worst.

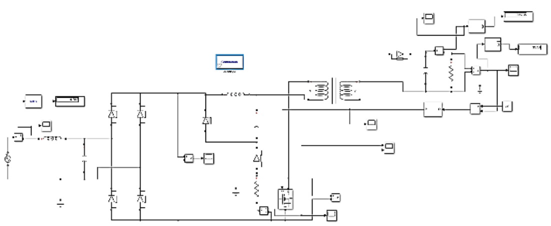


Figure 9 Integrated Buck Flyback Converter (IBFC)

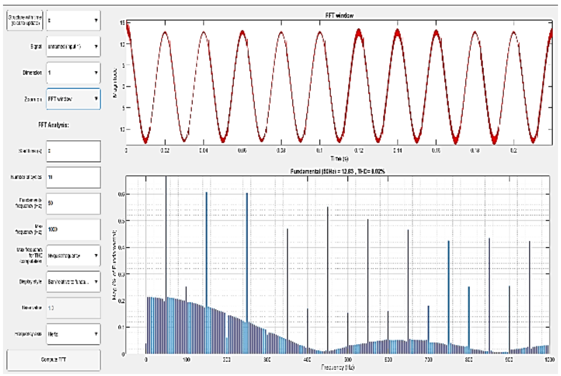


Figure 10 Integrated Buck Flyback Converter (IBFC) THD analysis

By solving this issue Interleaved Integrated Buck Flyback Converter (IIBFC) tropology is used. In this tropology adding a capacitor between the diode bridge & IBFC also add a third winding to the flyback transformer with same polarity. Figure 11.

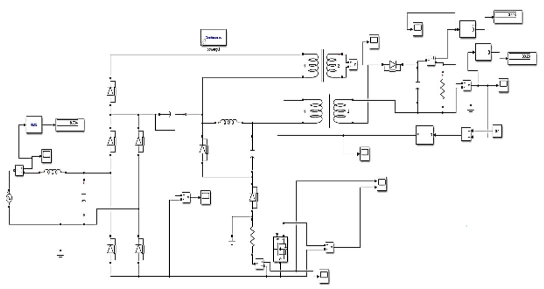


Figure 11 Interleaved Integrated Buck Flyback Converter (IIBFC)

Finally, we can improve the THD level 2.52% in figure 12. This is done by inserting an interleaved capacitor. The interleaved capacitor voltage is fixed by a third winding added to the flyback tr. That's why IIBFC reduces the ripple. Figure 13. is the output current top and bottom is the output voltage waveform.

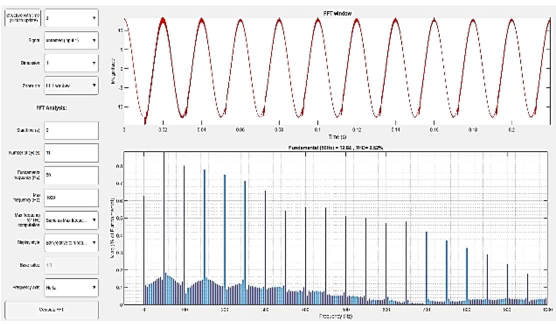


Figure 12. Interleaved Integrated Buck Flyback Converter (IIBFC) THD analysis

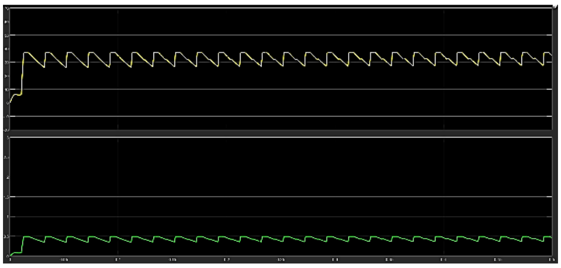


Figure 13 Output Voltage top and bottom is the output Current waveform

In figure 12. We get the THD value of 2.52%. But as we talking about dimming condition, reducing the output voltage we can change the power level. As we are setting the voltage to 25V in figure 14. We can see that the THD level is in the range 2.03% in figure 15.

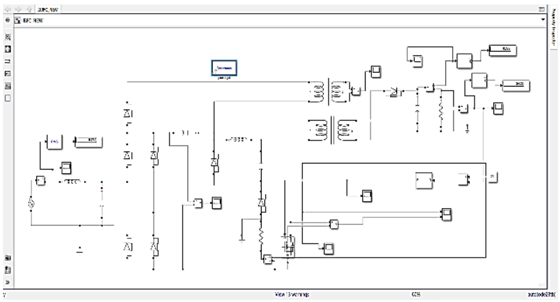


Figure 14 IIBFC Dimming condition 25V O/P

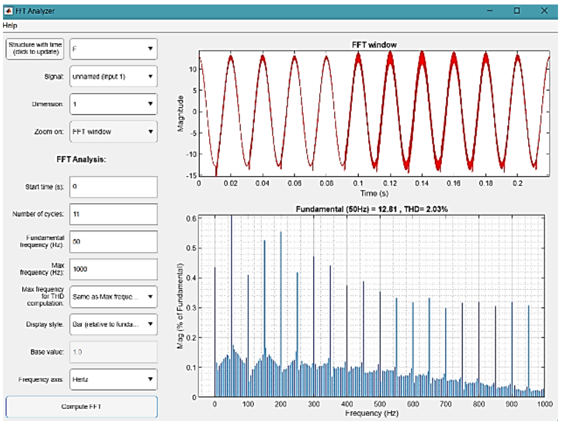
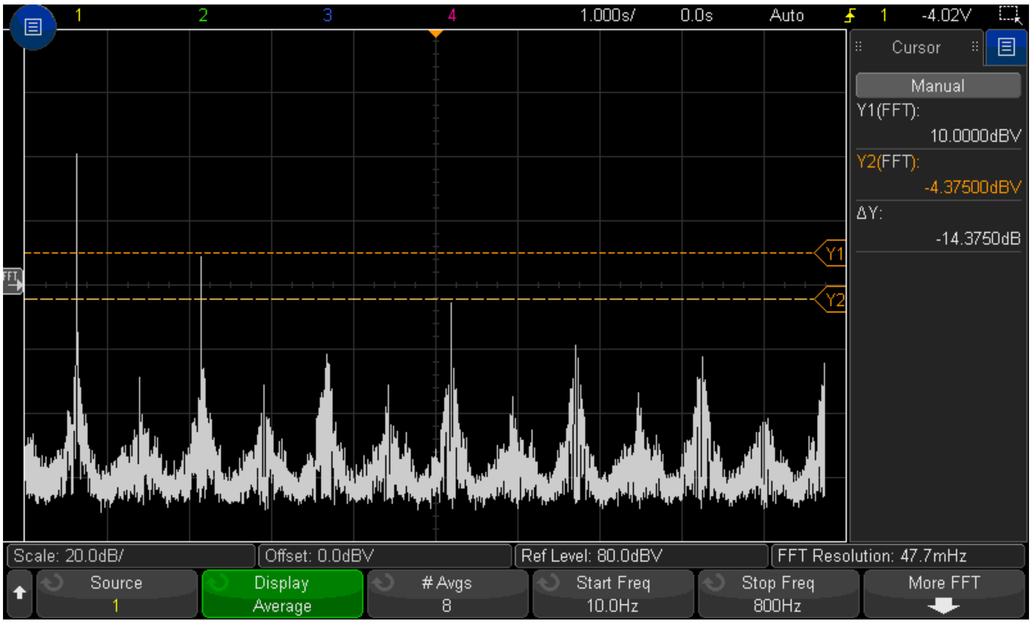


Figure 15 IIBFC Dimming condition 25V O/P THD Analysis

5. CONCLUSION

Using the Interleaved Integrated Buck Flyback Converter which is known as IIBFC we can get many advantages like It is a single switch driver so the switching loss is less and easy to control, very low THD at dimming condition, Lower ripple compared to IBFC, so lower value of capacitor is needed to design the topology and for all reason the driver has a more compact in size & lower cost. The main drawback is the output voltage is not smooth enough. There are some ripples in the output voltage, if further it could be negated the input current THD will more efficient, and another challenging issue is for the controlling purpose. There are so many blocks has been used in simulating the diagram, due to that ripple are little more.



HARMONICS

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1. INTRODUCTION

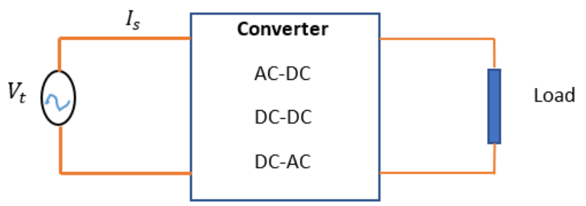
Harmonic signals are those type of signal which having frequency other than the fundamental frequency. We split this into two-part A) Current harmonics, B) Voltage harmonics. There are many effects due to current harmonics like, additional copper loss, additional core loss due to increased eddy current & also, electro-magnetic interference with closes communication circuit will be increased. And in case of voltage harmonics the effect is dielectric stress on insulator will be increased, Electro-static interference with nearby communication circuits also be affected.

2. SOURCES OF HARMONICS

We know that in case of non-linear load like power electronic converters, electronic devices, TV, Computer, Motor drives, Choke of tubular light those are the main reason for generating harmonics in system.

3. MATHEMATICAL ANALYSIS OF HARMONICS

Due to switching harmonics injected into system. The non-fundamental component of voltage, current or power.



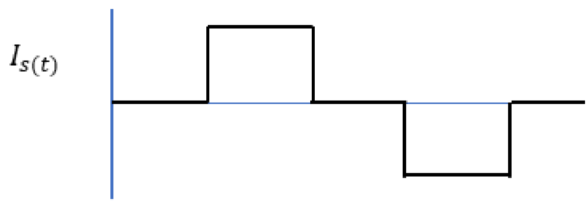
$V_t = V_m sin\omega t$,
$I_s(t) = non - sinusoidal\ but\ periodic,$

Any non-sinusoidal periodic function can be represented by Fourier series to analysis which harmonic component are present.

$I_s(t) = I_0 + I_{m1} sin\omega t + I_{m2} \sin 2\omega t + I_{m3} \sin 3\omega t + \ldots$

$I_s(t) = non - sinusoidal\ but\ periodic$

$I_0 = DC$,
$I_{m1} sin\omega t = 1st\ fundamental$
$I_{m2} sin\omega t = 2nd\ fundamental$
$I_{m3} sin\omega t = 3rd\ fundamental$



4. DISADVANTAGE OF HARMONICS

1. Rms current will increase, because it has Dc with all fundamental components (1st,2nd,3rd, etc)

$$\boldsymbol{I_{rms}} = \sqrt{(\boldsymbol{I_0})^2 + \frac{1}{2}(\boldsymbol{I_{m1}}^2 + \boldsymbol{I_{m2}}^2 + \boldsymbol{I_{m3}}^2 + \cdots)}$$

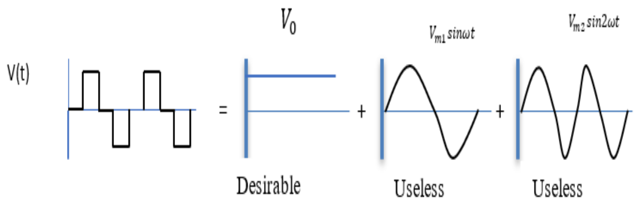
2. As I_{rms} increases cupper loss also increases
3. Power factor also go down as we know that $P = V * I * cos\emptyset$.
4. Problem arises on rotating machines, transformer, relay etc.

5. TYPE OF HARMONICS

Two types of harmonics are there.

A. DC Harmonics
B. AC Harmonics

5.1 **DC Harmonics**:



In case of DC harmonics in the equitation

$I_s(t) = I_0 + I_{m1}sin\omega t + I_{m2}\sin 2\omega t + I_{m3}\sin 3\omega t + \ldots$

We want only dc component.

The full wave Rectifier wave form is represented by,

$$V_0(t) = a_0 + \sum_{n=1}^{\infty} a_n cos\, n\omega_0 t + b_n sin\, n\omega_0 t$$

$$V_0(t) = a_0 + \sum_{n=1}^{\infty} c_n \sin(n\omega_0 + \emptyset_m)$$

$$c_n = \sqrt{{a_n}^2 + {b_n}^2} \quad \& \quad \emptyset_m = \tan^{-1}\frac{a_n}{b_n}$$

If we want to find out V_{Rms},

$$\boldsymbol{V_{rms}} = \sqrt{(\boldsymbol{a_0})^2 + \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots)}$$

In the DC harmonics, $\boldsymbol{a_0}$ is desirable (useful in dc load) and ${\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots$ those are useless in Dc load.

$$\boldsymbol{V^2}_{\boldsymbol{rms}} = (\boldsymbol{a_0})^2 + \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots)$$

$$\boldsymbol{V^2}_{\boldsymbol{rms}} - (\boldsymbol{a_0})^2 = \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots)$$

$$\sqrt{\boldsymbol{V^2}_{\boldsymbol{rms}} - (\boldsymbol{a_0})^2} = \sqrt{\frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots)}$$

Now,

$$\left[\sqrt{\frac{1}{2}({\boldsymbol{C_1}}^2 + {\boldsymbol{C_2}}^2 + {\boldsymbol{C_3}}^2 + \cdots)} = Harmonic\ voltage = V_{Oh}\right]$$

$$\sqrt{\boldsymbol{V^2}_{\boldsymbol{rms}} - (\boldsymbol{a_0})^2} = \boldsymbol{V_{oh}} \qquad (\boldsymbol{1})$$

That equitation (1) divides with $\boldsymbol{a_0}$,that is desirable.

So, we get,

$$\sqrt{\left(\frac{\boldsymbol{V_{rms}}}{\boldsymbol{a_0}}\right)^2 - \left(\frac{\boldsymbol{a_0}}{\boldsymbol{a_0}}\right)^2} = \frac{\boldsymbol{V_{oh}}}{\boldsymbol{a_0}}$$

$$\sqrt{\left(\frac{\boldsymbol{V_{rms}}}{\boldsymbol{a_0}}\right)^2 - 1} = \frac{\boldsymbol{V_{oh}}}{\boldsymbol{a_0}} \qquad (\boldsymbol{2})$$

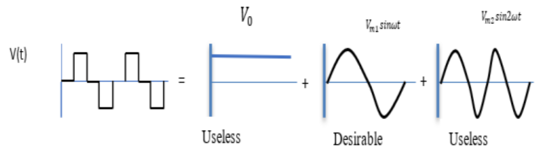
$\frac{\boldsymbol{V_{oh}}}{\boldsymbol{a_0}}$ *is also known as, "Voltage Ripple Factor"* (VRF)

And $\frac{\boldsymbol{V_{rms}}}{\boldsymbol{a_0}}$ known as "Form Factor" (FF).so we can also write the equitation (2),

$$VRF = \sqrt{(FF)^2 - 1}$$

5.2 AC Harmonics

If we consider the inverter waveform, that is non-sinusoidal wave but it's periodic



We know,

$V(t) = V_0 + V_{m1}sin\omega t + V_{m2}\sin 2\omega t + V\sin 3\omega t + \ldots$

$$\boldsymbol{V_{rms}} = \sqrt{(\boldsymbol{V_0})^2 + \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{V_{m1}}}^2 + {\boldsymbol{V_{m2}}}^2 + {\boldsymbol{V_{m3}}}^2 + \cdots)}$$

In the AC harmonics, $\boldsymbol{V_{m1}sin\omega t}$ is desirable (useful in ac load) and ${\boldsymbol{V_0}}^2, {\boldsymbol{V_{m2}}}^2, {\boldsymbol{V_{m3}}}^2 \ldots$ those are useless in Ac load.

$$\boldsymbol{V^2}_{\boldsymbol{rms}} = (\boldsymbol{V_0})^2 + \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{V_{m1}}}^2 + {\boldsymbol{V_{m2}}}^2 + {\boldsymbol{V_{m3}}}^2 + \cdots)$$

$$\boldsymbol{V^2}_{\boldsymbol{rms}} = (\boldsymbol{V_0})^2 + \frac{\boldsymbol{1}}{\boldsymbol{2}}({\boldsymbol{V_{m1}}}^2 + {\boldsymbol{V_{m2}}}^2 + {\boldsymbol{V_{m3}}}^2 + \cdots)$$

This is$\left(\frac{1}{2}({\boldsymbol{V_{m1}}}^2 + {\boldsymbol{V_{m2}}}^2 + {\boldsymbol{V_{m3}}}^2 + \cdots)\right)$ in turms of max value.we can represent it in RMS value.

$$\boldsymbol{V^2}_{\boldsymbol{rms}} = (\boldsymbol{V_0})^2 + ({\boldsymbol{V_{rms\,m1}}}^2 + {\boldsymbol{V_{rms\,m2}}}^2 + {\boldsymbol{V_{rms\,m3}}}^2 + \cdots)$$

$$\boldsymbol{V^2}_{\boldsymbol{rms}} - {\boldsymbol{V_{rms\,m1}}}^2 = (\boldsymbol{V_0})^2 + ({\boldsymbol{V_{rms\,m2}}}^2 + {\boldsymbol{V_{rms\,m3}}}^2 + \cdots)$$

$$({\boldsymbol{V^2}}_{\boldsymbol{0}} + {\boldsymbol{V_{rms\,m2}}}^2 + {\boldsymbol{V_{rms\,m3}}}^2 + = \text{Harmonics voltage} = V_{oh})$$

$\boldsymbol{V^2}_{\boldsymbol{rms}} - {\boldsymbol{V_{rms\,m1}}}^2 = \boldsymbol{V_{oh}}$ -----------------(1)

That equitation (1) divides with $\boldsymbol{V_{rms\,m1}}$,that is desirable.

So, we get,

$$\sqrt{\left(\frac{\boldsymbol{V_{rms}}}{\boldsymbol{V_{rms\,m1}}}\right)^2 - \left(\frac{\boldsymbol{V_{rms\,m1}}}{\boldsymbol{V_{rms\,m1}}}\right)^2} = \frac{\boldsymbol{V_{oh}}}{\boldsymbol{V_{rms\,m1}}}$$

$$\sqrt{\left(\frac{\boldsymbol{V_{rms}}}{\boldsymbol{V_{rms\,m1}}}\right)^2 - 1} = \frac{\boldsymbol{V_{oh}}}{\boldsymbol{V_{rms\,m1}}} \text{ -----------------(2)}$$

$$\frac{\boldsymbol{V_{oh}}}{\boldsymbol{V_{rms\,m1}}} =$$

$\boldsymbol{Total\ Harmonic\ Disturtion(THD)}$

THD is harmonic current or voltage by fundamental current or voltage.

THD will give us the amount of deviation are present in any kind of electrical output.

$$\frac{\boldsymbol{V_{rms\,m1}}}{\boldsymbol{V_{rms}}} = Disturtion\ Factor = g$$

So, we can write,

$$\sqrt{\left(\frac{1}{g}\right)^2 - 1} = \frac{\boldsymbol{V_{oh}}}{\boldsymbol{V_{rms\,m1}}}$$

$$\sqrt{\left(\frac{1}{g}\right)^2 - 1} = \boldsymbol{THD}$$

Displacement power Factor (DPF) or Fundamental Power Factor (FPF) is the cosine of the angle between fundamental voltage ($\boldsymbol{V_{rms\,m1}}$) to fundamental Current ($\boldsymbol{I_{rms\,m1}}$).

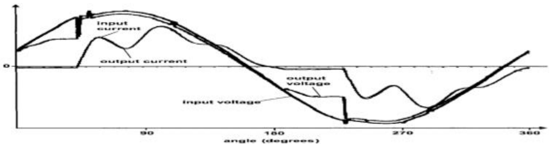
6. PROBLEMS OF HARMONICS

Some of the problems associated with the harmonic interface are as follows:

1. Increase losses in the supply transformer.
2. Unwanted tripping of circuit breakers.
3. Possible cause of system resonance when power factor correction equipment is present on the system. This may impose high voltages, currents on the system which can be dangerous.
4. Premature ageing of electrical insulation.
5. Premature failure of power factor correction capacitor installations
6. Malfunctions or failure of some electrical circuits.
7. Efficiency loss in transmission and distribution depending on RMS current increase in lines.

7. EFFECTS OF HARMONIC

Harmonic distortion causes various problems towards the power system. Over voltage problems, instability of zero voltage crossing firing circuits, overheating of neutral conductors and transformers and communication interferences are some of the current problems which found from harmonic distortion due to non -linear loads.



8. FOURIER SERIES TO ANALYSIS OF HARMONICS

$$V_0(t) = a_0 + \sum_{n=1}^{\infty} a_n cos\, n\omega_0 t + b_n sin\, n\omega_0 t$$

It is the representation of any non-sinusoidal periodic function in sine or co-sine waveform.

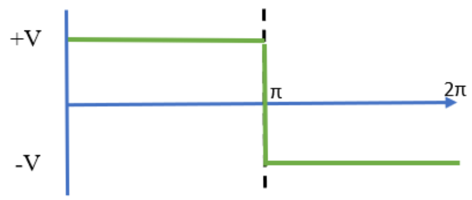
Where,

$$a_0 = \frac{1}{2\pi}\int_{<2\pi>}^{'} f(t)dt \ \&$$

$$a_n = \frac{1}{\pi}\int_{<2\pi>}^{'} f(t) cos\, n\omega_0 t d\omega_0 t\ ,$$

$$b_n = \frac{1}{\pi}\int_{<2\pi>}^{'} f(t) sin\, n\omega_0 t d\omega_0 t$$

If our source voltage is rectangular and we want to make Fourier series of this waveform.



This is the rectangular waveform which is odd function & in case of odd function we know,

$$a_0 = a_n = 0$$

So, we only get b_n,

$$b_n = \frac{1}{\pi}\int_{<2\pi>}^{'} f(t) sin\, n\omega_0 t d\omega_0 t$$

In this waveform if we split this into 2 sections +ve half & -ve half we will get something like

$$b_n = \frac{2}{2\pi}\int_{\pi}^{0} V sin\, n\omega_0 t d\omega_0 t + \int_{\pi}^{2\pi} -V sin\, n\omega_0 t d\omega_0 t$$

$$b_n = \frac{V}{\pi}\left[\left(-\frac{cosn\omega_0 t}{n}\right)_{\pi}^{0} + \left(\frac{cosn\omega_0 t}{n}\right)_{\pi}^{2\pi}\right]$$

$$b_n = \frac{V}{n\pi}\{cosn\pi - (-cosn0)\} + \{cos2n\pi - (cosn\pi)\}$$

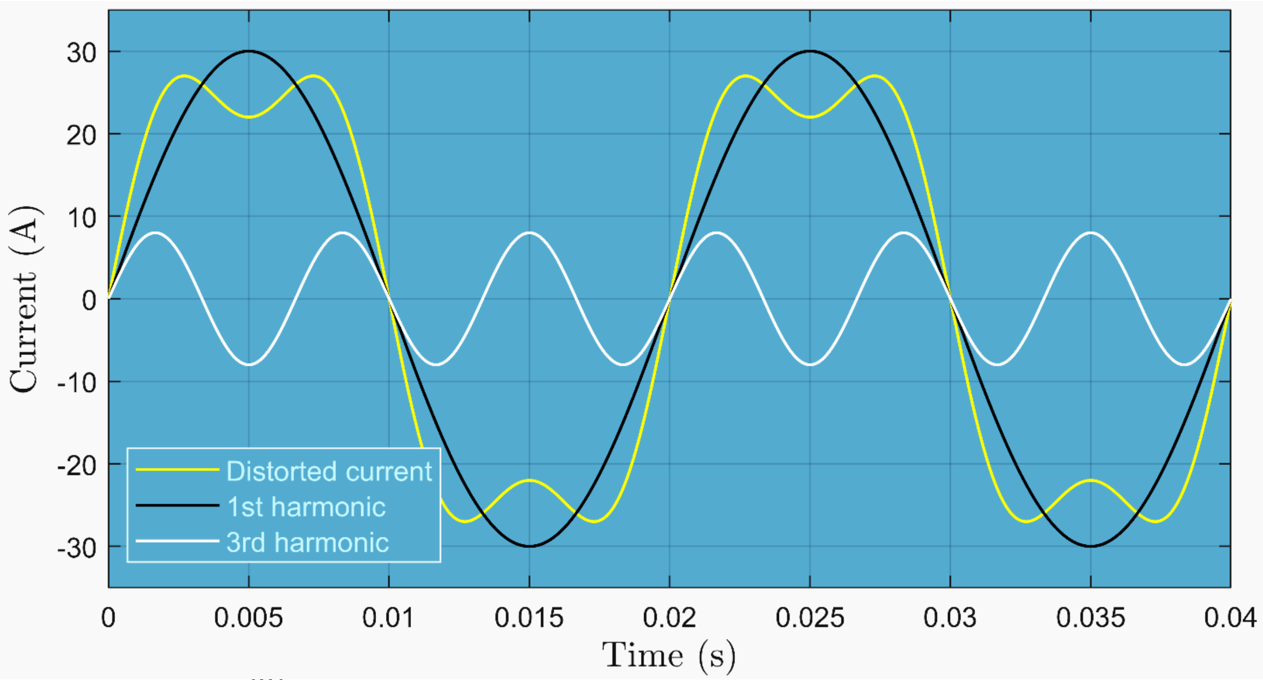
$b_n = \frac{2V}{n\pi}\{1 - cosn\pi\}$ -----------------(3)

Now in equitation 3 if we take two cases, when n is even (2,4,6…) then,

$$b_n = \frac{2V}{n\pi}\{1 - cosn\pi\}$$

$$b_n = 0$$

And in case of odd (n=1,3,5…)



$$b_n = \frac{2V}{n\pi}\{1 - cosn\pi\}$$

$$b_n = \frac{2V}{n\pi}\{1 - (-1)\}$$

$$b_n = \frac{4V}{n\pi}$$

So finally, we get

$V_0(t) = \sum_{n=1,3,5}^{\alpha} \frac{4V}{n\pi} sin\, n\omega_0 t$ -----------------(4)

9. CONCLUSION

Harmonic analysis is a process of studying the various components of a complex waveform to identify and understanding the presence of harmonics. Harmonics are multiples of fundamental frequency in a signal or waveform. The frequency representation is found by using the Fourier transform for functions on the real line or by Fourier series for periodic functions.

ADITYA-L1 MISSION

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1. INTRODUCTION

Aditya-L1 is a satellite dedicated to the comprehensive study of the Sun. It has 7 distinct payloads developed, all developed indigenously. Five by ISRO and two by Indian academic institutes in collaboration with ISRO.

2. HISTORY

Aditya in Sanskrit means the Sun. L1 here refers to Lagrange Point 1 of the Sun-Earth system. For common understanding, L1 is a location in space where the gravitational forces of two celestial bodies, such as the Sun and Earth, are in equilibrium. This allows an object placed there to remain relatively stable with respect to both celestial bodies.

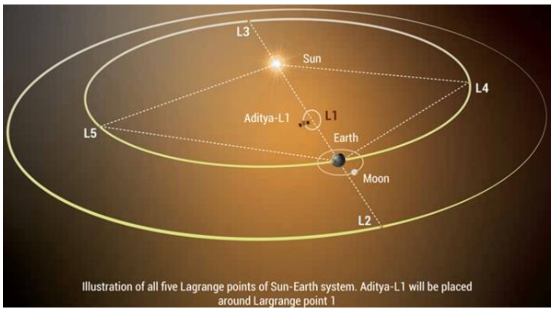

Illustration of all five Lagrange points of Sun-Earth system. Aditya-L1 will be placed around Largrange point 1

3. LAUNCHING

Following its scheduled launch on September 2, 2023, Aditya-L1 stays Earth-bound orbits for 16 days, during which it undergoes 5 manoeuvres to gain the necessary velocity for its journey. Subsequently, Aditya-L1 undergoes a Trans-Lagrangian1 insertion manoeuvre, marking the beginning of its 110-day trajectory to the destination around the L1 Lagrange point. Upon arrival at the L1 point, another manoeuvre binds Aditya-L1 to an orbit around L1, a balanced gravitational location between the Earth and the Sun. The satellite spends its whole mission life orbiting around L1 in an irregularly shaped orbit in a plane roughly perpendicular to the line joining the Earth and the Sun.

4. THE STRATEGIC PLACEMENT

The strategic placement at the L1 Lagrange point ensures that Aditya-L1 can maintain a constant, uninterrupted view of the Sun. This location also allows the satellite to access solar radiation and magnetic storms before they are influenced by Earth's magnetic field and atmosphere. Additionally, the L1 point's gravitational stability minimizes the need for frequent orbital maintenance efforts, optimizing the satellite's operational efficiency.

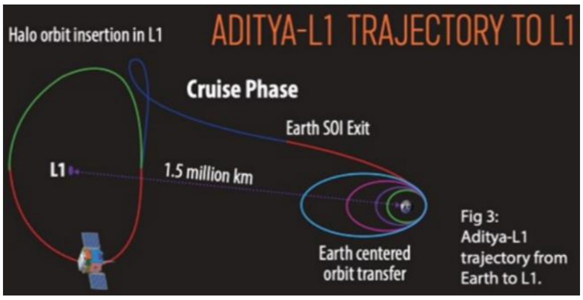

Fig 3: Aditya-L1 trajectory from Earth to L1.

5. CONCLUSION

Aditya-L1 will stay approximately 1.5 million km away from Earth, directed towards the Sun, which is about 1% of the Earth-Sun distance. The Sun is a giant sphere of gas and Aditya-L1 would study the outer atmosphere of the Sun. Aditya-L1 will neither land on the Sun nor approach the Sun any closer.

FUTURE TRENDS IN ELECTRICAL ENGINEERING USING DRONES

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1. INTRODUCTION

A drone is a type of Unmanned Aerial Vehicle (UAV). Drones are more commonly referred to as UAVs or unmanned aircraft systems (UAS). A drone can be described as a flying robot in simple words. It is a device that can be controlled or flown remotely using software-guided flight plans in its built-in systems, which work together with on-board sensors and GPS. Unmanned aerial vehicles (UAVs) were first widely used by the military. Initially, UAVs were used in anti-aircraft practice, intelligence gathering, and, more recently, as weapons systems.

2. CIVILIAN APPLICATIONS OF DRONES

Today, UAVs are used in a variety of civilian applications, including:

- Search and Rescue
- Surveillance
- Traffic Monitoring
- Weather Monitoring
- Firefighting
- Personal Use
- Drone-Based Photography
- Videography
- Agriculture
- Delivery Services

3. WORKING OF DRONES

Flight mode and navigation are two of the fundamental functions of a drone. In order to fly, a drone needs a power source such as a battery or fuel, as well as a rotor, propeller and frame. A drone frame is usually made of lightweight composite material to minimize weight and improve manoeuvrability. A drone requires a controller. The controller allows the operator to use remote control to launch, manoeuvre and land the drone. The controller communicates with the drone via radio waves, including Wi-Fi.

4. COMMON DRONE FEATURES AND COMPONENTS

Drones have a large number of components, including:

- Electronic Speed Controllers, Which Control A Motor's Speed And Direction
- Flight Controller
- GPS Module

- Battery
- Antenna
- Receiver
- Cameras
- Sensors, Including Ultrasonic Sensors And Collision Avoidance Sensors
- Accelerometer, Which Measures Speed
- Altimeter, Which Measures Altitude5. DRONE FEATURES
- Drone features vary based on the use it is put to. Examples of features include:
- Various types of cameras with high-performance, zoom and gimbal steady-cam and tilt capabilities
- Artificial intelligence (AI) that enables the drone to follow objects
- Augmented reality features that superimpose virtual objects on the drone's camera feed
- Media storage format
- Maximum flight time, which determines how long the drone can remain in the air
- Maximum speeds, including ascent and descent
- Hover accuracy
- Obstacle sensory range
- Altitude hold, which keeps the drone at a fixed altitude
- Live video feed
- Flight logs
- Navigational systems
- Most navigation systems, including GPS, are built into the nose of the drone. A drone's GPS sends its exact location to the drone's controller. On-board altimeters can send altitude information. Altimeters also help the drone maintain a specific altitude when the controller assigns it to the drone.
- Sensors can be installed on drones for a variety of purposes, such as ultrasonic detection, laser detection, LiDAR detection, time of flight detection, chemical detection, stabilization and orientation detection, visual detection, still and video acquisition, and more. Ultraviolet (UV) sensors collect UV wavelengths from red, green, and blue wavelengths. Multispectral (visible and nonvisible) sensors collect infrared and ultraviolet wavelengths. Other commonly used drone features include Accelerometers, Gyroscopes, Magnetometers, Barometers, and GPS.
- The utilization of thermal sensors for surveillance and security purposes is becoming increasingly popular, such as the monitoring of livestock and the detection of heat signatures. Additionally, hyperspectral sensors are becoming increasingly popular, as they are able to detect the presence of minerals and vegetation. These sensors are ideal for applications related to crop health and water quality, as well as surface composition. Additionally, some drones are now equipped with sensors that can detect obstacles in five directions, allowing for the avoidance of collisions.

For landing, drones use visual positioning systems with downward-facing cameras and ultrasonic sensors. The ultrasonic sensors determine how close the drone is to the ground.

6. TYPES OF DRONES AVAILABLE

There are two main types of drone platforms:

6.1 Rotor: including single-rotor and multi-rotor, such as Tricopters, Quadcopters, Hexacopters and Octocoptors

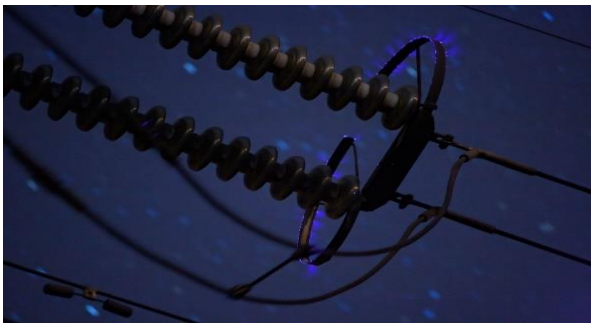
6.2 Fixed-wing: which include the hybrid Vertical Take-Off and Landing (VTOL) drones that don't require runways. Non-military drones are generally either personal or hobbyist ones or commercial aircraft.

7. THE FUTURE OF DRONES IN THE ELECTRICAL POWER INDUSTRY

Drone technology and application in the Power industry is growing at a rapid pace. Utilities have wasted no time jumping on board since the Federal Aviation Administration authorized drones for commercial use in 2015.

8. BENEFITS TO ELECTRIC UTILITIES

The task of maintaining and inspecting high voltage transmission and distribution lines can be difficult, dangerous and costly. As a result, utilities are increasingly looking toward drones as a safe and effective tool to assist them in their T&D operations. On average, U.S. utilities collectively spend between $6 billion to $8 billion a year to inspect and maintain their power lines with helicopters and ground crews. Drones drastically cut the costs of power line inspections for utilities. They also improve safety, increase reliability and reduce response time across transmission and distribution systems. Drones also give utilities the ability to quickly and efficiently identify threats to the energy grid. Drone technology can assist engineers in the process of designing the electrical infrastructure as well. Drones with integrated LiDAR systems can produce Photogrammetry, LiDAR mapping and creation of RGB/multi-spectral colorized LiDAR point clouds. When added with other sensors, drones can also gather other useful data through infrared sensors, ultraviolet cameras and radio frequency sensors.



9. UAV CORONA INSPECTIONS

Corona discharge is a luminous partial discharge from conductors and insulators due to ionization of the air, where the electrical field exceeds a critical value. This process is accompanied by excitation of Nitrogen molecules, leading to emission of UV radiation.

Corona activity on High Voltage equipment may or may not be destructive, however in general it is not a desirable occurrence, since it signifies a defect in a component design or installation which creates a local high electric field. Corona discharges can generation of corrosive materials, like ozone and nitrogen oxides that yield nitric acids when exposed to moisture. These corrosive materials shorten the life span of high voltage lines and substations components. They also generate Radio interference (RI/ RFI) on AM frequencies which affect radio and television broadcasts. Utilities are typically made aware of corona by complaints of faulty radio or television signals. Because corona are invisible in daylight with the naked eye, maintenance crews will investigate by aiming devices such a corona camera or radio antenna at suspected areas, and track corona. Corona activity generates very little heat and therefore is not detected with Infra-Red cameras.

10. CONCLUSION

Recent advancements in UV Camera designs, have made way to lightweight UAV mountable systems. This application allows for a cost effective scan of the substations and transmission networks.

INDIA'S LARGEST FLOATING SOLAR POWER PLANT

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1. INTRODUCTION

Ramagundam in Telangana State is known for its blistering summer heat. Locally, it is sometimes referred to as 'Agnigundam (firewell) in Telugu language. For all those travelling to Delhi by train during summers (especially, non AC class) from Hyderabad, the few hours of journey through Ramagundam, Mancherial and Adilabad to Nagpur will always be remembered for braving the heat. In 1978, the public sector, NTPC came up with its first thermal unit in the town to generate power and supply to the southern state. Very soon, it became synonymous with Ramagundam. Today, the NTPC has grown into 2640 MW capacity plant, one of its largest sites in the country.

2. HISTORY

In mid-2022, Ramagundam, now part of Peddapalli district added a new first with the commissioning of the country's largest Floating Solar Power Plant as on date by the NTPC. It's about 5 km from the town.The 100 MW, Solar Photovoltaic (PV) unit executed by the BHEL is a 4-5 hour drive from Hyderabad and is quite scenic, spread over the waters of the balancing reservoir of the NTPC Power plant. A unique feature of the project is that all the electrical equipment is floating on the reservoir. Engineers constructed ferro-cement floating platforms (15.5 m x8 m x 1.2 m) on which Inverter, Transformer & HT breaker is placed.

3. OVERVIEW OF THE PROJECT

In just over six months into its operational phase, the project has raised the expectations of setting up similar plants and rapidly increasing the generation of clean, renewable and environmentally friendly power in the long term.The NTPC awarded the Rs 423 crore contract to BHEL in June 2019 as an EPC package. The project is developed on 450 acres of the Balancing reservoir of NTPC Ramagundam Station. The project consists of 4 units of 25 MW each with a total capacity of 100 MW AC and 145 MW DC. The Power evacuation of the project is at 33 kV level through NTPC Ramagundam switchyard. About 4.5 lakh solar PV modules, all made in India were used in the plant. The anchoring of the project is done through bottom anchoring by using pre-cast concrete blocks of 9 Ton weights. The plant is designed to generate 222.965 MU in the first year of its operation with a capacity utilisation factor of 24.45%.

4. ADVANTAGES OF THE PROJECT

The major advantages of this project are minimizing the water evaporation, no land usage and higher generation of power in comparison to ground based solar plants. Further, Coal consumption of 1,65,000 Tons / year can be reduced and 2,10,000 tons of Co2 emission per year can be avoided. The ED of the Ramagundam Unit, Sunil Kumar said, the NTPC will soon have 300 MW of floating solar power in place in the country. Earlier, NTPC declared Commercial operation of the 92 MW Floating Solar at Kayamkulam (Kerala) and 25 MW Floating Solar at Simhadri (Andhra Pradesh). Another couple of units are under construction in different regions. However, some experts argue that the floating solar plants could have an impact on the water ecosystem in the lakes, reservoirs or other water bodies on which these plants are located, if adequate precautions are not taken in terms of contamination of water and consequent impact on marine life, if any.

5. NTPC RENEWABLES PLANS

The thrust on renewable energy in the context of India's global commitments to reducing fossil fuel also put the responsibility on the NTPC to diversify. It has firmed up plans to have 60GW capacity through renewable energy sources by 2032, constituting nearly 45% of its overall power portfolio. NTPC Renewables, it's new identity created a few years ago has a commissioned capacity of more than 1500 MW of solar power projects under own capacity. These include some sizeable solar power projects in Bilhaur, Ananthapuram, Bhadla, Mandsaur etc. According to reports, the company has firmed up plans to set up an ambitious 755 MW floating solar park to be developed at DVC's Tilaiya and Panchet reservoirs in Jharkhand in north-eastern India. NTPC Renewables, on behalf of Green Valley Renewable Energy, its joint venture (JV) with Damodar Valley Corporation (DVC), has opened a tender for 220 kV transmission assets to evacuate the power generation of the project.

6. CONCLUSION

The other major project in the pipeline of the power utility is the Khavda Solar Project in Gujarat State, one of the largest individual solar power plants in the world (1,568 MWp).The project implementer is Sterling and Wilson (S&W). It is supported by Nextracker Inc. which is providing the bifacial optimized NX Horizon solar tracker technology with heavily domestic manufactured content, aligned with the Government of India's "Make-in-India" initiative. S&W and Nextracker have implemented several projects in India, Australia, Latin America, Africa, and the Middle East regions over the years, according to reports.

SMART POWER GRID: AN INTEGRATING COMBINATION OF POWER RESOURCES

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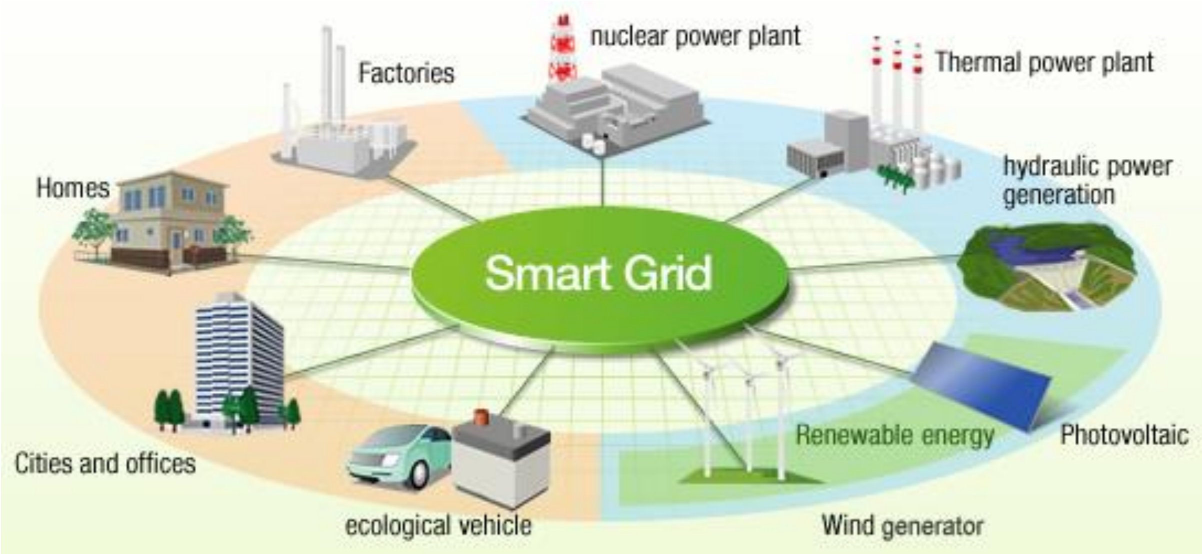

1. INTRODUCTION

In present scenario, there is a lot of power demand to meet up the industrial requirements. To implement systematic management of energy requirement for different zone of nation, it necessarily required a strategic implementation of distribution of energy. The earlier power storage has been to some extent able to control the transmission losses of the system and improve the efficiency. But day by day a huge energy gap has been developed in both the end of generation as well as demand. So, nowadays, a latest technology has introduced which may be the solution of the earlier problem which is known as "Smart Grid Technology". Our former president Dr. APJ Abdul Kalam dreams for a society which says about "Energy for all and energy forever." The deficit of power generation have been attempted to mitigate between supply and demand through developments of national grid connected system where all the national power generation sources are connected to national grid, the energy management is implemented. "Smart Grid" or "Electric Grid" is important as it establishes energy independence and environmentally sustainable economic growth. Smart grid is no single entity but an aggregate of multiple network and power generation companies where multiple operators employing varying levels of communication and coordination most of which is manually controlled.

2. THE VISION OF SMART GRID

Transform the Indian power sector in to a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders.

2.1 Reliability

A reliable grid provides power when and where its users need it and of the quality they value. It Provides ample warning of growing problems and withstands most disturbances without failing. It takes corrective action before most users affected.

2.2 Flexibility

The rapid and safe interconnection of distributed generation and energy storage at any point on the system at any time.

2.3 Economical

Economic grids operate under the basic law of supply and demand, resulting in fair prices and adequate supply.

2.4 Efficiency

An efficient grid employs strategies that lead to cost control minimal transmission and distribution losses efficient power production and optimal asset utilisation while providing consumers with options for managing their usage.

2.5 Security

Maintain the security of supply, ensure integration and interoperability. The two way communication capability of the smart grid covering the end to end system, the need for physical as well as cyber security of all critical assets is essential.

3. APPLICATION OF SMART GRID IN VARIOUS DOMAINS

3.1 Customer

The applications can be categorized into energy management system (EMS) is a core application providing the capability for building display of customer usage, reading of meters, and integration with building management systems and the enterprise, and remote load control, monitoring and control of distributed generation, the EMS provides auditing/logging for system troubleshooting and security purposes as well.

3.2 Operation

This domain consists of the applications for distributed network operation, including the Supervisory Control and Data Acquisition (SCADA) systems to monitor and control the status of devices in bulk generation, transmission, and distribution system. It also consists of the applications for general operations, including energy usage, energy generation, meter logs, and meter test results to make energy data available to authorized parties.

3.3 Service Provider

Service provider consists of applications such as building/ home management which is to monitor and control building/ home energy, and respond to Smart Grid signals while minimizing the impact on building occupants. Billing management is to manage customer billing information and account management is to manage the supplier and customer business accounts.

3.4 Markets

The main applications include the distributed energy resource aggregation, wholesaler and retailer marketing. To be specific, retailers sell power to end customers and may play aggregation role as a broker between customers and the market. Most of the retailers are connected to a trading organization to allow participation in the wholesale market. Other applications include dynamic pricing, trading, and market management. Traders are participants in markets and include aggregators for provision and consumption and curtailment and other qualified parties.

3.5 Bulk Generation

This includes bulk generation plant control, measure, and traditional energy generation. In particular, the plant control permits the operations domain to manage the flow of power and ensures the reliability of the system. Measurement is used to provide visibility into the flow of power and know the condition of the systems in the field remotely. Other applications include renewable energy generation and storage.

3.6 Transmission and Distribution

This application includes distributed energy generation (i.e., conventional and non-conventional), distributed storage, substation, and local distribution network monitoring and control. Substation management and control contain switching, protection and control equipment, i.e., sub-stations connecting generation and storage with distribution. Substations may also connect two or more transmission lines. Other applications include local network monitoring and control used to measure, record, and control with the intent of protecting and optimizing the operation of electricity transmission and distribution.

4. CONCLUSION

Smart grid is the most comprehended research in the electrical system from a long period of time and it is developing day by day. From all the data the author has observed that the smart grid system will provide a different scenario for the distribution of power as well as it is neither centred to consumers nor to the suppliers but is equally beneficial to both of them. Electrical energy distribution through smart grid will reduce consumption by 10% - 20% with emission of CO_2 by 30% as per electrical power research institute. By the implementation of smart grid in the power system the consumers will realize a greater reliability of the system as well as will have a better control over power consumed and supplied. The operators will have an improved monitoring system as well as better control capabilities that will help them to supply in the overgrowing power demands to fulfil the needs.

FEATHERS ON THE CROWN

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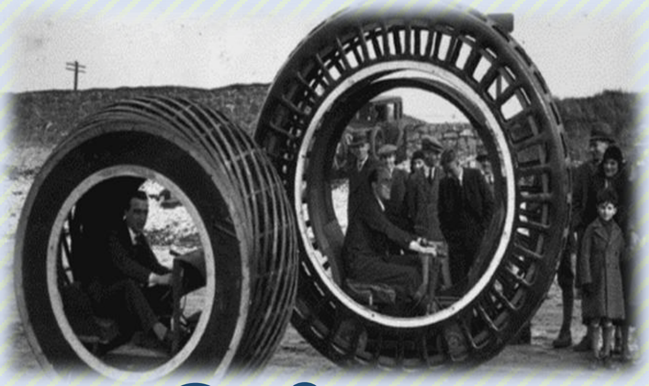
2^{nd} Year Students of Electrical Department were the Champions in Intra College Annual Cricket Tournament, 2023

Raj Gupta and his Team (2nd Year) Acquired the 2nd Position in Science Exhibition "Technosphere-2023"

Students Published Their Final Year Project Paper in International Journal

Organized Workshop on 'Hands on Practice on Electrical Wiring" for Community Development

Fun Facts



Designed to be an electric car consisting of purely one gigantic wheel, the 1930 *Dynasphere* was inspired by a Leonardo da Vinci sketch. However, despite inventor J.A. Purves' enthusiasm, the mono-wheel did not get past its prototype phase as steering and braking functions were next to none.

El Apóstol (English: The Apostle) is a 1917 lost Argentine animated film using cutout animation. Italian-Argentine immigrants Quirino Cristiani and Federico Valle directed and produced, respectively.

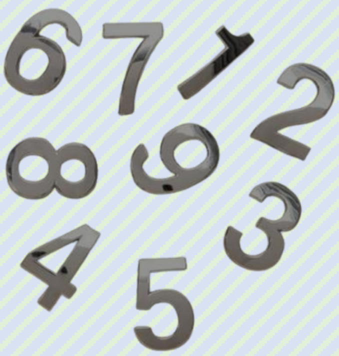
Cancer in the heart is extremely rare as heart cells do not divide.

Firefighters use wetting agents to make water wetter. The chemicals reduce the surface tension of plain water so it's easier to spread and better soaks into objects, which is why it's known as *"wet water"*.

A floating post office - India has the largest postal network in the world with over 1, 55,015 post offices. A single post office on an average serves a population of 7,175 people. The floating post office in Dal Lake, Srinagar, was inaugurated in August 2011.

The Spanish national anthem has no words. The '*Marcha Real*' is one of only four national anthems in the world (along with those of Bosnia and Herzegovina, Kosovo, and San Marino) to have no official lyrics.

Some fungi create zombies, then control their minds. The tropical fungus *Ophiocordyceps* infects ants' central nervous systems. Once it has been in an insect's body for nine days, it has complete control over the host's movements.



- Every odd number has an "e" in it.
- The symbol for division (i.e.÷) is called an *obelus*.

The # symbol isn't officially called hashtag or pound. Its technical name is octothorpe. The "octo" means "eight" and refers to its points, though reports disagree on where "thorpe" came from.

The Eiffel Tower can grow more than six inches during the summer. The high temperatures make the iron expand.

Bees can fly higher than Mount Everest. Bees can fly higher than 29,525 feet above sea level, according to National Geographic. That's higher than Mount Everest, the tallest mountain in the world.

Glass is actually a liquid, it just flows very, very slowly. Being neither liquid, nor solid, explaining glass is a lot harder than some might think. In a glass, molecules still flow, but at a very low rate that it's barely perceptible.

A rubber tire is technically one single, giant, polymerized molecule. Some molecules can be very big, but most are still microscopic. Not the vulcanized tire, though — it's all one, big molecule! Basically, the vulcanized tire is all made of large polymers chains that have been crosslinked together with covalent bonds.

Earwax is actually a type of sweat!