"SAVE ENERGY'

Electric Times

EEE- AITS RAJAMPET

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Vision	MISSION
We envision the Department as one of the best in the region with a stimulating environment to make an impact on and lead in the field through its Education and Research.	The mission of the Department is to provide an excellent and comprehensive education in the field of Electrical & Electronics Engineering which in turn moulds the students for a wide range of careers and to exhibit a high level of professionalism, ethical behavior and social responsibility.

Article

Electric Cars- Evolution from Past to Present

-Dr.J.SreeRanganayakulu

Abstract: This article is about electric automobilesAn electric car or electric vehicle (EV) is a passenger automobile that is propelled by an electric traction motor, using only energy stored in on-board batteries. Compared to conventional internal combustion engine (ICE) vehicles, electric cars are quieter, more responsive, have superior energy conversion efficiency and no exhaust emissions and lower overall vehicle emissions[1] (however the power plant supplying the electricity might generate its own emissions).

Introduction

The term "electric car" normally refers to plug-in electric vehicle, typically a battery electric vehicle (BEV), but broadly may also include plug-in hybrid electric vehicle (PHEV), range-extended electric vehicle (REEV) and fuel cell electric vehicle (FCEV). The electric vehicle battery typically needs to be plugged into a mains electricity power supply for recharging in order to maximize the cruising range. Recharging an electric car can be done at a variety of charging stations; these charging stations can be installed in private homes, parking garages and public areas. Worldwide, 10 million plug-in electric cars were sold in 2022, a total of 14 percent of new car sales, up from 9 percent in 2021. Many countries have established government incentives for plug-in electric vehicles, tax credits, subsidies, and other non-monetary incentives while several countries have legislated to phase-out sales of fossil fuel cars, to reduce air pollution and limit climate change. EVs are expected to account for nearly one-fifth of global car sales in 2023, according to the International Energy Agency (IEA). China currently has the largest stock of electric vehicles in the world, with cumulative sales of 5.5 million units through December 2020, although these figures also include heavy-duty commercial vehicles such as buses, garbage trucks and sanitation vehicles, and only accounts for vehicles manufactured in China.In the United States and the European Union, as of 2020, the total cost of ownership of recent electric vehicles is cheaper than that of equivalent ICE cars, due to lower fueling and maintenance costs.

In 2023 the Tesla Model Y became the world's best selling car. The Tesla Model 3 became the world's all-time best-selling electric car in early 2020, and in June 2021 became the first electric car to pass 1 million global sales. Together with other emerging automotive technologies such as autonomous driving, connected vehicles and shared mobility, electric cars form a future mobility vision called Autonomous, Connected, Electric and Shared (ACES) Mobility.

History of Electric Cars

Early developments

Robert Anderson is often credited with inventing the first electric car some time between 1832 and 1839. The following experimental electric cars appeared during the 1880s: In 1881, Gustave Trouvé presented an electric car driven by an improved Siemens motor at the Exposition internationale d'Électricité de Paris. In 1882, Werner von Siemens presented the world's first trolleybus in Berlin In 1884, over 20 years before the Ford Model T, Thomas Parker built an electric car in Wolverhampton using his own specially-designed high-capacity rechargeable batteries, although the only documentation is a photograph from 1895. In 1888, the German Andreas Flocken designed the Flocken Elektrowagen, regarded by some as the first "real" electric car. In 1890, Andrew Morrison introduced the first electric car to the United States.

Electricity was among the preferred methods for automobile propulsion in the late-19th and early-20th centuries, providing a level of comfort and an ease of operation that could not be achieved by the gasoline-driven cars of the time. The electric vehicle fleet peaked at approximately 30,000 vehicles at the turn of the 20th century. In 1897, electric cars first found commercial use as taxis in Britain and in the United States. In London, Walter Bersey's electric cabs were the first self-propelled vehicles for hire at a time when cabs were horse-drawn. In New York City, a fleet of twelve hansom cabs and one brougham, based on the design of the Electrobat II, formed part of a project funded in part by the Electric Storage Battery Company of Philadelphia. During the 20th century, the main manufacturers of electric vehicles in the United States included Anthony Electric, Baker, Columbia, Anderson, Edison, Riker, Milburn, Bailey Electric, and Detroit Electric. Their electric vehicles were quieter than gasolinepowered ones, and did not require gear changes. Six electric cars held the land speed record in the 19th century. The last of them was the rocket-shaped La Jamais Contente, driven by Camille Jenatzy, which broke the 100 km/h (62 mph) speed barrier by reaching a top speed of 105.88 km/h (65.79 mph) in 1899. Electric cars remained popular until advances in internal-combustion engine (ICE) cars and mass production of cheaper gasoline- and diesel-powered vehicles, especially the Ford Model T, led to a decline. ICE cars' much quicker refueling times and cheaper production-costs made them more popular. However, a decisive moment came with the introduction in 1912 of the electric starter motor that replaced other, often laborious, methods of starting the ICE, such as hand-cranking.

Modern electric cars

In the early 1990s the California Air Resources Board (CARB) began a push for more fuel-efficient, lower-emissions vehicles, with the ultimate goal of a move to zero-emissions vehicles such as electric vehicles. In response, automakers developed electric models. These early cars were eventually withdrawn from the U.S. market, because of a massive campaign by the US automakers to discredit the idea of electric cars. California electric-auto maker Tesla Motors began development in 2004 of what would become the Tesla Roadster, first delivered to customers in 2008. The Roadster was the first highway-legal all-electric car to use lithium-ion battery cells, and the first production all-electric car to travel more than 320 km (200 miles) per charge.

Better Place, a venture-backed company based in Palo Alto, California, but steered from Israel, developed and sold battery charging and battery swapping services for electric cars. The company was publicly launched on 29 October 2007 and announced deployment of electric vehicle networks in Israel, Denmark and Hawaii in 2008 and 2009. The company planned to deploy the infrastructure on a country-by-country basis. In January 2008, Better Place announced a memorandum of understanding with Renault-Nissan to build the world's first Electric Recharge Grid Operator (ERGO) model for Israel. Under the agreement, Better Place would build the electric recharge grid and Renault-Nissan would provide the electric vehicles. Better Place filed for bankruptcy in Israel in May 2013. The company's financial difficulties were caused by mismanagement, wasteful efforts to establish toeholds and run pilots in too many countries, the high investment required to develop the charging and swapping infrastructure, and a market penetration far lower than originally predicted.

The Mitsubishi i-MiEV, launched in 2009 in Japan, was the first highway-legal series production electric car, and also the first all-electric car to sell more than 10,000 units. Several months later, the Nissan Leaf, launched in 2010, surpassed the i MiEV as the best selling all-electric car at that time.

Starting in 2008, a renaissance in electric vehicle manufacturing occurred due to advances in batteries, and the desire to reduce greenhouse-gas emissions and to improve urban air quality. During the 2010s, the electric vehicle industry in China expanded greatly with government support. The subsidies introduced by the Chinese government will however be cut by 20 to 30 percent and phased out completely before 2023. Several automakers marked up the prices of their electric vehicles in anticipation of the subsidy adjustment, including Tesla, Volkswagen and Guangzhou-based GAC Group, which counts Fiat, Honda, Isuzu, Mitsubishi, and Toyota as foreign partners.

In July 2019 US-based Motor Trend magazine awarded the fully-electric Tesla Model S the title "ultimate car of the year".In March 2020 the Tesla Model 3 passed the Nissan Leaf to become the world's all-time best-selling electric car, with more than 500,000 units delivered; it reached the milestone of 1 million global sales in June 2021.

Environmental aspects

Electric cars have several benefits when replacing ICE cars, including a significant reduction of local air pollution, as they do not emit exhaust pollutants such as volatile organic compounds, hydrocarbons, carbon monoxide, ozone, lead, and various oxides of nitrogen. Similar to ICE vehicles, electric cars emit particulates from tyre and brake wear which may damage health, although regenerative braking in electric cars means less brake dust. More research is needed on non-exhaust particulates. The sourcing of fossil fuels (oil well to gasoline tank) causes further damage as well as use of resources during the extraction and refinement processes. Depending on the production process and the source of the electricity to charge the vehicle, emissions may be partly shifted from cities to the plants that generate electricity and produce the car as well as to the transportation of material. The amount of carbon dioxide emitted depends on the emissions of the electricity source and the efficiency of the vehicle. For electricity from the grid, the life-cycle emissions vary depending on the proportion of coal-fired power, but are always less than ICE cars.

The cost of installing charging infrastructure has been estimated to be repaid by health cost savings in less than three years. According to a 2020 study, balancing lithium supply and demand for the rest of the century will require good recycling systems, vehicle-to-grid integration, and lower lithium intensity of transportation.

Some activists and journalists have raised concerns over the perceived lack of impact of electric cars in solving the climate change crisis compared to other, less popularized methods. These concerns have largely centered around the existence of less carbon-intensive and more efficient forms of transportation such as active mobility, mass transit and e-scooters and the continuation of a system designed for cars first.

Article

Photovoltaic (PV) power systems and solar power Generation

Solar power generation: When sunlight strikes on photovoltaic solar panels solar electricity is produced. That is why this is also referred to as photovoltaic solar, or PV solar.

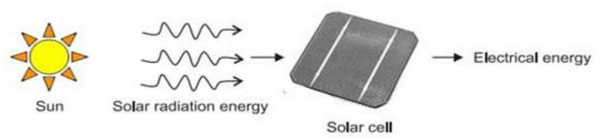

Figure 1: Solar power generation

Principles of Solar Electricity

Generation of electricity by using solar energy depends upon the photovoltaic effect in some specific materials. There are certain materials that produce electric current when these are exposed to direct sun light. This effect is seen in combination of two thin layers of semiconductor materials. One layer of this combination will have a depleted number of electrons. When sunlight strikes on this layer it absorbs the photons of sunlight ray and consequently the electrons are excited and jump to the other layer. This phenomenon creates a charge difference between the layers and resulting to a tiny potential difference between them. The unit of such combination of two layers of semiconductor materials for producing electric potential difference in sunlight is called solar cell.

Silicon is normally used as the semiconductor material for producing such solar cell. For building cell silicon material is cut into very thin wafers. Some of these wafers are doped with impurities. Then the un-doped and doped wafers are then sandwiched together to build solar cell. Metallic strip is then attached to two extreme layers to collect current. Conductive metal strips attached to the cells take the electrical current. One solar cell or photovoltaic cell is not capable of producing desired electricity instead it produces very tiny amount of electricity hence for extracting desired level of electricity desired number of such cells are connected together in both parallel and series to form a solar module or photovoltaic module.

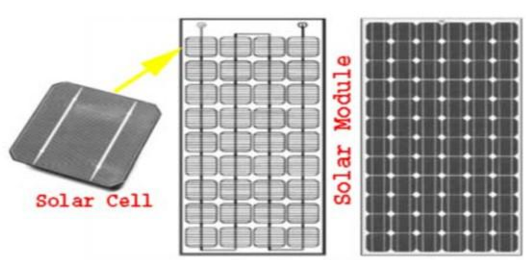

Figure 2: Principles of Solar Electricity

Application of Solar Electricity

Solar electric power generation system is useful for producing moderate amount of power. The system works as long as there is a good intensity of natural sunlight. The place where solar modules are installed should be free from obstacles such as trees and buildings otherwise there will be shade on the solar panel which affects the performance of the system. It is a general view that solar electricity is an impractical alternative of conventional source of electricity and should be used when there is no traditional alternative of conventional source of electricity available. But this is not the actual case. Often it is seem that solar electricity is more money saving alternative than other traditional alternatives of conventional electricity. It is always economical to install a solar light or a solar power source where it is difficult and costly to get point from local electric supply authority such as in remote garden, shed or garage where standard electric supply point is not available.

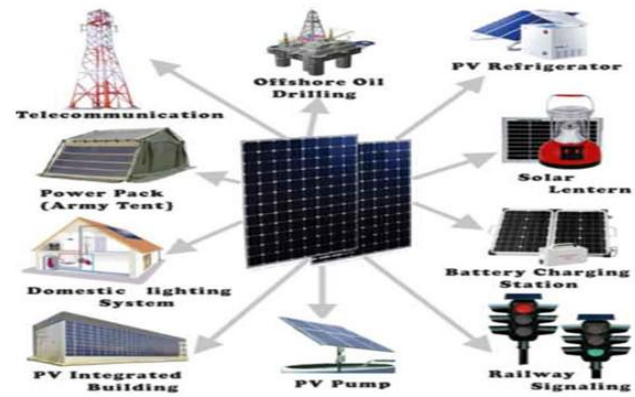

Figure 3: Application Solar Electricity

Article

Wind energy

Wind is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover. This wind flow, or motion energy, when "harvested" by modern wind turbines, can be used to generate electricity.

Wind Turbines

Wind turbines, like aircraft propeller blades, turn in the moving air and power an electric generator that supplies an electric current. Simply stated, a wind turbine is the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and makes electricity.

Wind Turbine Types

Modern wind turbines fall into two basic groups; the horizontal-axis variety, like the traditional farm windmills used for pumping water, and the vertical-axis design, like the eggbeater-style Darrieus model, named after its French inventor. Most large modern wind turbines are horizontal-axis turbines.

Turbine Components

Horizontal turbine components include: • blade or rotor, which converts the energy in the wind to rotational shaft energy; • a drive train, usually including a gearbox and a generator; • a tower that supports the rotor and drive train; and • Other equipment, including controls, electrical cables, ground support equipment, and interconnection equipment.

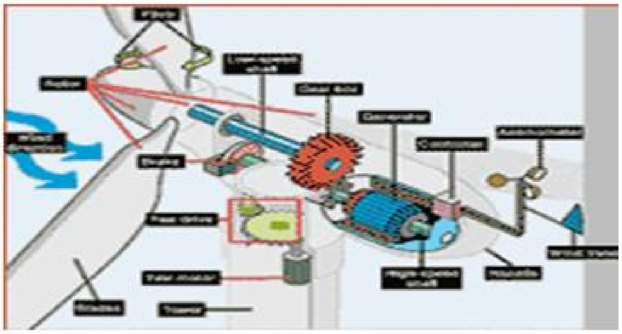

Figure 4: Wind turbine

Turbine Configurations

Wind turbines are often grouped together into a single wind power plant, also known as a wind farm, and generate bulk electrical power. Electricity from these turbines is fed into a utility grid and distributed to customers, just as with conventional power plants.

Wind Turbine Size and Power Ratings

Wind turbines are available in a variety of sizes, and therefore power ratings. The largest machine has blades that span more than the length of a football field, stands 20 building stories high, and produces enough electricity to power 1,400 homes. A small home-sized wind machine has rotors between 8 and 25 feet in diameter and stands upwards of 30 feet and can supply the power needs of an all-electric home or small business. Utility-scale turbines range in size from 50 to 750 kilowatts. Single small turbines, below 50 kilowatts, are used for homes, telecommunications dishes, or water pumping.

Wind farms consist of many individual wind turbines which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electricity, competitive with or in many places cheaper than coal or gas plants. Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electricity to isolated off-grid locations.

Wind power is very consistent from year to year but has significant variation over shorter time scales. It is therefore used in conjunction with other electric power sources to give a reliable supply. As the proportion of wind power in a region increases, a need to upgrade the grid and a lowered ability to supplant conventional production can occur. Power management techniques such as having excess capacity, geographically distributed turbines, dispatch able backing sources, sufficient hydroelectric power, exporting and importing power to neighboring areas, using vehicle-to-grid strategies or reducing demand when wind production is low, can in many cases overcome these problems. In addition, weather forecasting permits the electricity network to be readied for the predictable variations in production that occur.

Figure 5: Offshore Wind power

Offshore wind power The world's second full-scale floating wind turbine (and first to be installed without the use of heavy-lift vessels), Wind Float, operating at rated capacity (2 MW) approximately 5 km offshore of Póvoa de Varzim, Portugal

Offshore wind power refers to the construction of wind farms in large bodies of water to generate electricity. These installations can utilize the more frequent and powerful winds that are available in these locations and have less aesthetic impact on the landscape than land based projects. However, the construction and the maintenance costs are considerably higher.

Siemens and Vestas are the leading turbine suppliers for offshore wind power. DONG Energy, Vattenfall and E.ON are the leading offshore operators. As of October 2010, 3.16 GW of offshore wind power capacity was operational, mainly in Northern Europe. According to BTM Consult, more than 16 GW of additional capacity will be installed before the end of 2014 and the UK and Germany will become the two leading markets. Offshore wind power capacity is expected to reach a total of 75 GW worldwide by 2020, with significant contributions from China and the US.

Student Article

Power Flow Control in Power Transmission System by using UPFC

- K. Dilip Kumar, IV EEE

Introduction

Electrical power systems are a large interconnected network that requires a careful design to maintain the system with continuous power flow operation without any limitations. Flexible Alternating Current Transmission System (FACTS) is an evolving technology used to help electric utilities fully utilize their transmission assets. This concept was first introduced by N.G Hingorani, in 1988.

Many types of FACTS devices have been proposed, among them Unified Power Flow Controller (UPFC) is a versatile and flexible device in the FACTS family of controllers which has the ability to simultaneously control all the transmission parameters of power systems i.e. voltage, impedance and

phase angle which determines the power flow of a transmission line.
The UPFC seen to be consists of two Voltage Source Converters (VSCs), one VSC is connected in series to the transmission line through a series transformer, similarly the other is connected in shunt to the transmission line through a shunt transformer and both are connected back to back through a D.C storage capacitor.

UPFC Operating Principle

The UPFC consists of two voltage source converters, one connected in series to the transmission line through a series transformer and the other in shunt to the transmission line through a shunt transformer, both are connected back to back through a DC link and can modelled as two ideal voltage sources between the two buses.
UPFC allows simultaneous control of active power flow, reactive power flow, and voltage magnitude at the UPFC terminals. Alternatively, the controller may be set to control one or more of these parameters in any combination or to control none of them. The active power demanded by the series converter is drawn by the shunt converter from the AC network and supplied to bus m through the DC link.
Following figure shows the voltage source model of the UPFC. Zse and Zsh are the impedances of the two transformers between the line and UPFC. In addition to providing a supportive role in the active power exchange that take place between a series converter and the AC system, the shunt converter may also generate or absorb reactive power in order to provide independent voltage magnitude regulation at its point of connection with the AC system.

Newton Raphson Algorithm for Incorporation in the UNIFIED POWER FLOW CONTROLLER

From the mathematical modelling point of view, the set of nonlinear, algebraic equations that describe the electrical power network under the steady state conditions are solved for the power flow solutions. Over the years, several approaches have been put forward to solve for the power flow equations. Early approaches were based on the loop equations and methods using Gauss-type solutions.
This method was laborious because the network loops has to be specified by hand by the systems engineer. The drawback of these algorithms is that they exhibit poor convergence characteristics when applied to the solution of the networks. To overcome such limitations, the Newton-Raphson method and derived formulations were developed in the early 1970s and since then it became firmly established throughout the power system industry.
Steps to Solve the Newton-Raphson Algorithm
Step 1: Read the input of the system data that includes the data needed for conventional power flow calculation i.e. the number and types of buses, transmission line data, generation, load data and location of UPFC and the control variables of UPFC i.e. the magnitude and angles of output voltage series and shunt converters.
Step 2: Formation of admittance matrix Ybus of the transmission line between the bus i and j.
Step 3: Combining the UPFC power equations with network equation, we get the conventional power flow equation:
Step 4: The conventional jacobian matrix are formed due to the inclusion of UPFC. The inclusion of these variables increases the dimensions of the jacobian matrix.
Step 5: In this step, the jacobian matrix is modified and power equations are mismatched
Step 6: The bus bar voltages are updated at each iteration and convergence is checked.
Step 7: If convergence is not achieved in the next step the algorithm goes back to the step 6 and the jacobian matrix is modified and the power equations are mismatched until convergence is attained.
Step 8: If the convergence achieved in Step 7, the output load flow is calculated for PQ bus that includes the Bus bars voltages, generation, transmission line flow and losses.

Student Article

Energy storage technology: Three trends to watch

- J.Uday Kiran, III EEE

Introduction

Energy storage market dynamics are shaping the evolution of battery formats, components and production.Rapid growth in deployments is making the energy storage system (ESS) sector the new competitive battlefield for battery manufacturers. Whether diversifying from the electric vehicle (EV) market or focusing specifically on ESS, it's an attractive opportunity to capitalise on a strong outlook over the next decade.
We recently kicked off a series of energy storage technology reports, drawing on insight from our Energy Storage Service. The first report focuses on how ESS market dynamics are driving developments in lithium-ion cell components and designs. Following is an overview of three key trends to watch.

1. The divergence between batteries for ESS and EVs is accelerating

A combination of technology, market, manufacturing and policy factors is driving rapid changes in the lithium-ion battery market landscape. With ESS uptake accelerating, the specific performance requirements for ESS batteries are increasingly being addressed by divergence from the market for batteries used in EVs.
In contrast to EV batteries, where the focus is on improving energy density to boost range and reducing charging time, the priorities for ESS batteries are cost, durability and storage duration. Stationary batteries need to be competitive with conventional peak and frequency modulation technology on price. They also need a longer lifespan of up to 10,000 charging cycles – three times that of EV batteries. In addition, there is increasing demand for longer-duration ESS applications.
Policy will also influence the divergence of the battery market. In the US, the terms of the Inflation Reduction Act entitle ESS projects that comprise at least 40 percent domestic content (rising to 55 percent by 2029) to a 10 percent additional investment tax credit. By comparison, requirements for critical mineral sourcing for EV batteries will be much more stringent, and require traceability.
This will add to production costs and drive separation of

battery supply for the ESS market to avoid the price of ESS batteries being needlessly increased.

2. LFP cathode chemistry is gaining momentum in energy storage applications

New technology such as advanced silicon-based and lithium metal anode technologies and all-solid-state batteries are aimed at boosting energy density. As such they will prioritise the EV and consumer electronics markets.

In contrast, developments in batteries for energy storage applications focus on the particular needs of the sector. Lithium iron phosphate (LFP) cathode technology is fast becoming popular in the ESS market, thanks to its safety performance, long cycle life and the abundance (and therefore lower cost) of iron and phosphate raw materials.

Another technology which is moving quickly in terms of commercialisation and has attractive prospects for stationary storage applications is the sodium-ion (Na-ion) cell. Na-ion batteries work on a similar principle to lithium-ion (Li-ion) batteries but are likely to be less sensitive to rising lithium, cobalt and nickel prices than LFP.

3. Cost reduction is driving innovation in cell size and format for ESS

Ultimately, developments in battery size and format are also moving fast in the ESS market. A meaningful way of reducing cost is by increasing the capacity and size of cells. This reduces the number of system components, bringing down bill of materials (BOM) costs, simplifying assembly and integration, and reducing the burden on the battery management system (BMS).

Already 280 Ah (ampere hours) is becoming the new standard for LFP batteries in grid-scale applications, with larger capacities of up to 560 Ah and a higher cycle life of up to 12,000 times in the pipeline. However, larger cells need increased manufacturing capabilities and also have implications for safety management.

In terms of battery format, prismatic cells currently dominate grid-scale ESS, mainly because they are favoured by Chinese battery manufacturers. They are space efficient but expensive to manufacture and die relatively quickly due to less efficient thermal management.

By comparison, cylindrical cells are relatively safe, cheap and easy to manufacture, and economical to run due to their long calendar life. Their shape creates cavities between cells in a pack, reducing volumetric energy density, however, this is less of an issue for ESS applications than for EVs. We forecast the latest generation of larger cylindrical 46xx LFP cells will be used in various energy storage markets over the next decade.

Student Article

Latest Power and Electric Trends That Will Shape the Future

-P.Chandra Sudheer, II EEE

Introduction

As technology continues its ever-changing wave of innovations and updates, engineers must strive to stay ahead of electrical engineering trends. Because the future of electronics influences several industries, such as automotive, healthcare, manufacturing, telecommunications, banking and finance, retail, education, energy, aerospace, and security. In short, regardless of the industry, engineers will be responsible for pioneering and building new ways of interacting with technology.

1. Wireless Power Transfer

Did you ever worry about forgetting to pack your charger when getting ready to leave on a trip? Or maybe you did forget it. This trend in electrical engineering eliminates any need for concern or inconvenience. Though still in its early stages of development and production, wireless power transfer is a promising innovation for the future of electronics. In short, wireless power transfer (WPT), also known as wireless energy transfer, is the transmission of electrical energy from a power source to a receiver without the use of interconnecting wires. WPT systems use time-varying electromagnetic fields for energy transmission. These systems ride along the same fields and waves as wireless communication devices. Essentially, a receiver in a device picks up the power, which allows for contact less charging, powering, and data communication.

Innovative Uses

If you think wireless power transfer is limited to your phone or computer, think again. Electric vehicle charging docks, security software, and heart pumps have all been discussed as potential use cases for wireless power transfer. In short, wireless power transfer has transformed or will transform several aspects of our lives.

Smart Homes: Wireless power transfer can be used to power a range of smart home devices such as lighting, climate control, security systems, and more.

Automotive: WPT can enable contactless charging of electric vehicles, providing a more efficient and convenient way of powering them up.

Industrial: WPT can be used to power industrial machinery and equipment, reducing the need for wires and cables and increasing safety.

Wearables: WPT could be used to power and charge wearables such as fitness trackers, smartwatches, and medical devices.

Remote Areas: WPT can be used to provide energy in remote areas where it is difficult to connect to the grid.

2. Wearable Tech

While wearable technology is nothing new, its constant innovation and new iterations require the industry to think on its feet (literally) to meet consumer demand and to stay ahead of electrical engineering trends.

Forward-Thinking Fashion

But wearable tech is far more than just a watch or an electrical engineering trend. It can become a life-saving device. Electrical engineers have been hard at work developing wearable pieces that prevent injury and workplace accidents. For example, SolePower boots are specifically designed to eliminate on-the-job injuries. The boots contain technology that monitor the wearer's real-time location, environmental conditions, and even fatigue. All in all, these boots are meant to improve situational awareness and improve safety in the workplace.

Beyond boots, smart clothing is another form of wearable technology that incorporates sensors and other electronics into fabric, tracking physiological signals (heart rate, body temperature, and respiration) and providing feedback to the user. Some brands, such as Sensoria, track user performance and activity metrics, such as heart rate, steps taken, calories burned, and distance traveled. Others, like Spire Health, are designed to send ongoing, real-time health statistics to medical professionals to monitor health conditions. Smart clothing can also be used to connect to other devices such as smartphones, tablets, and laptops.

And there are other potential applications of smart clothing as well, such as tracking location, helping wearers find help when they are lost or in danger, detecting injuries and falls, and alerting emergency contacts.

3. Electric Power Distribution and Supply

Almost gone are the days of customer reliance on power from a single, localized power company. Today's power generation industry trends dictate a better, more efficient way to generate power with smart grids and microgrids.

Microgrids

A microgrid "consists of interconnected loads and distributed energy resources" that comprise "a single controllable entity with respect to the grid." Or to put it more simply, microgrids are self-contained power sources that provide power for smaller, community-based areas.

This grid can operate in two modes, island or connected, depending on need and a community's power usage. There are five types of microgrids, which are used based on a community's location: campus environment, community, remote off-grid, military base, and commercial. Microgrids have several advantages.

Reliability: They can provide a source of power in the event of an outage. They can also help reduce the frequency and duration of outages. Cost: Their small size and decentralized nature makes them more cost-effective than traditional grid infrastructure.

Sustainability: Renewable energy sources can be incorporated into microgrids, reducing dependence on fossil fuels.

Efficiency: They provide local power that is tailored to the specific needs of the area.

Scalability: They are easy to expand and adjust to changing energy needs.

Power in the Hands of the Customer

Not only do microgrids and smart grids improve communication between power supply companies and technology, but they also put the power in the hands of the customer—literally. With smart grids, customers can generate their own power and sell their surplus currents. Microgrids allow communities to generate their power on-site, when they need it. This power generation trend has the potential to change the infrastructure of electricity delivery as we know it.

4. The Internet of Things

If there's one subject matter knowledge critical to the success of an electrical engineer, it's the Internet of Things. The Internet of Things (IoT) is a network of connected devices that can communicate with each other and with other devices. These devices can be anything from phones and computers to sensors, actuators, and other electronic components. Through the IoT, data can be collected, analyzed, and used to control and automate processes.

Room for Improvement

While there are standard connections that consumers have come to expect, there's always room for improvement. Consider the upgrade from 4G to 5G. 5G networks, which are faster and more reliable than 4G networks, provided faster download and upload speeds, greater bandwidth, and lower latency. This upgrade allowed more devices to be connected to the internet at once, and for these devices to communicate more quickly and efficiently. 5G also improved more advanced applications, such as augmented and virtual reality. Still, the IoT creates room for more innovation in electrical engineering, such as in the following:

smart homes
smart cities
industrial automation
smart meters
home energy storage systems

As the future of electronics increasingly requires an internet connection, the IoT is an electrical engineering trend that won't be going away any time soon.

Electrical engineers have the potential to create and define our future. Whether through cars or power generation trends, smart houses or smart boots, trends in electrical engineering continue to influence the future of electronics.

Genius is One Percent inspiration, Ninety-Nine Percent perspiration